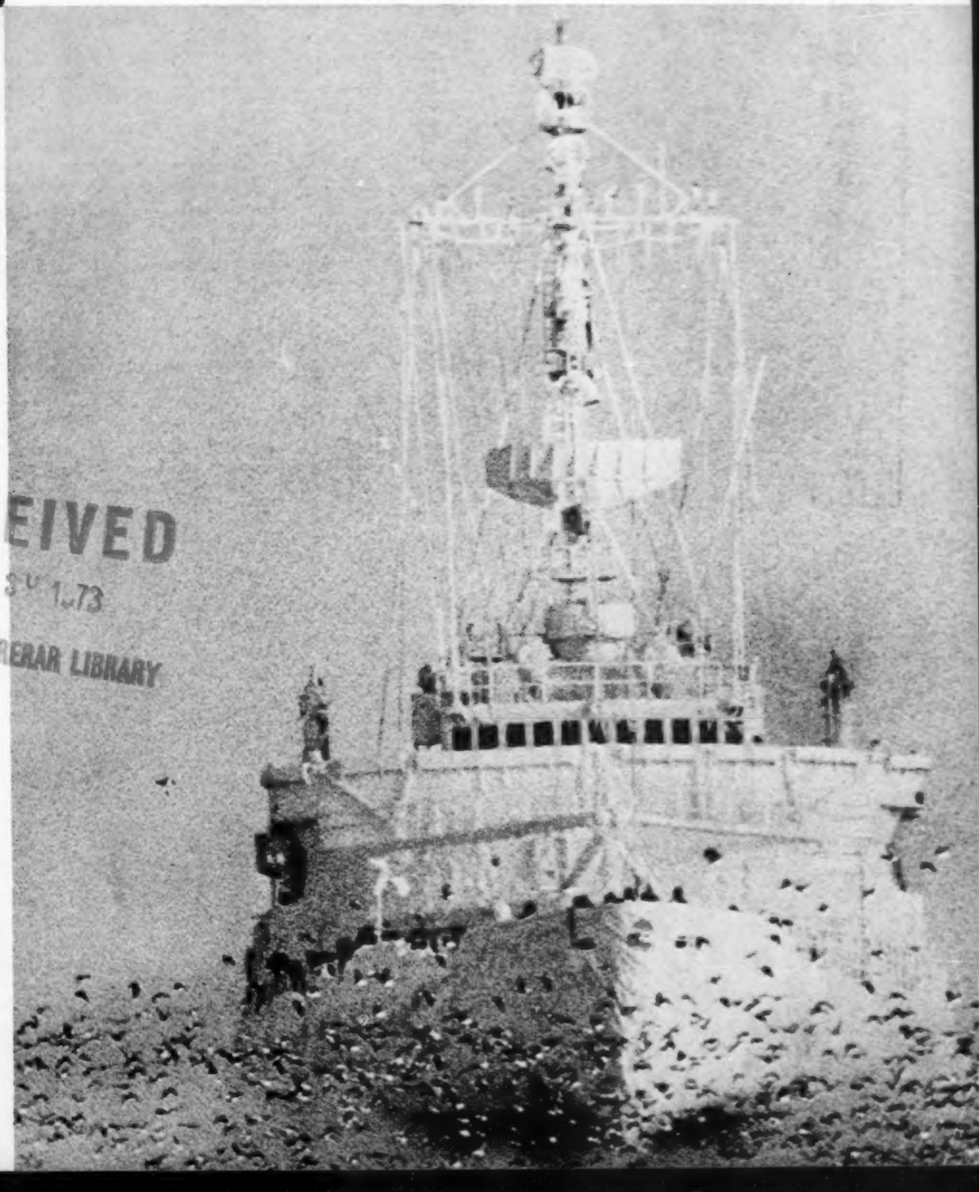
A UNITED STATES DEPARTMENT OF COMMERCE PUBLICATION

MARINERS WEATHER LOG

VOLUME 17, NUMBER 3

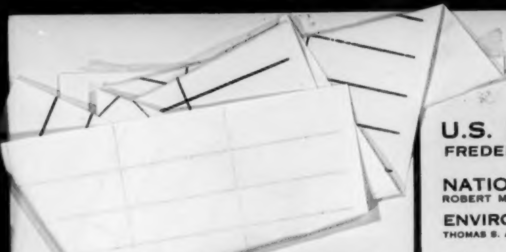
MAY 1973



U.S. DEPARTMENT OF COMMERCE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

ENVIRONMENTAL DATA SERVICE



MARINERS WEATHER LOG

ELWYN E. WILSON, EDITOR

DONNA J. GRANT, EDITORIAL ASSISTANT

MAY 1973
VOLUME 17, NUMBER 3
WASHINGTON, D.C.

Routing
Master______________________
Observing Officers
____
____
____
Radio Officer____________________

PARTICIPATE IN AMVER

PLEASE PASS THIS ISSUE ALONG

U.S. DEPARTMENT OF COMMERCE
FREDERICK B. DENT, SECRETARY

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
ROBERT M. WHITE, ADMINISTRATOR

ENVIRONMENTAL DATA SERVICE
THOMAS S. AUSTIN, DIRECTOR

Cover: Like a white ghost floating on a cloud, the ice-shrouded EDISTO, carefully makes its way to Milwaukee through sea smoke in frigid temperatures, on January 15, 1972. The arctic icebreaker stirred up this flock of ducks while on duty helping to extend the Great Lakes navigation season. See articles on pages 135 and 139. United Press International Photo.

The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical has been approved by the Director of the Office of Management and Budget through June 30, 1973.

Copies are available to persons or agencies with a marine interest from the Environmental Data Service, Page Bldg. 2 (D54), 3300 Whitehaven St., Washington, D.C. 20235

MARINERS WEATHER Log

SEA ICE

Part 1 Major Features and Physical Properties

Walt Wittmann
U.S. Naval Oceanographic Office
Washington, D.C.

and

Marvin D. Burkhart
Office of the Oceanographer
Alexandria, Va.

Editor's Note: This article on Sea Ice will be presented in a three-part series. Part 1 will include background, history, and the major features and physical properties. Part 2 will be a discussion of the distribution in North American waters and forecast services; and part 3, a discussion of the distribution in Eurasian waters and forecast services.

Other than a few very early vague accounts of mariners' contact with sea ice, little arctic exploration was undertaken, except for the traverses of the Vikings, until stimulated by a desire to find a direct route to China and the Orient, in the 16th century. The promises of mineral wealth, furs, and whaling and fishing grounds were further stimulants to a renewed interest which occurred in the early 17th century. Although exploration efforts continued throughout the 18th century, it was not until the 19th century that significant progress was made in understanding ice navigation and cold weather operations. This progress resulted from accelerated attempts to penetrate the Canadian Archipelago and to reach the "pole." These efforts were highlighted by the search for the Franklin expedition, lost in the Northwest Passage and continued through the early 20th century.

On the other or "Pacific Side" of the Arctic, Nordenskiold showed, in the late 19th century, that a Northwest Passage was feasible. Perhaps one of the more important achievements of that era was the "Fram" expedition organized and planned by the Norwegian scientist and explorer F. Nansen. This expedition, which utilized a specially constructed, rounded, and reinforced wooden-hull ship, was the first truly scientific expedition into the Arctic Basin. Subsequent explorations and support for surface operations were made largely by air. Here U.S.S.R. aviators were leaders in ice observing, and by the late 1920's made ice surveys over the classical Northern Sea Route and adjacent seas of the northern Eurasian mainland a regular systematic reality.

Recent renewed interest in transport over, through, and under the ice of the polar seas stems from the discovery of oil on the North Slope of Alaska. This led to the two experimental voyages of the MANHATTAN (figs. 1 and 2), a specially constructed, icebreaking oil tanker. Efforts to date to get this oil out of the Arctic have been mainly in design of exploratory drilling rigs, oil-tanker vehicles, and terminal facility concepts that would adapt to and withstand the pressure exerted by the multi-year ice. In this regard, the Liquified Natural Gas (LNG) carrier must also be considered for

Figure 1.--The snow-covered ice almost looks like a desert scene as the MANHATTAN encounters tough going in northern Baffin Bay.

Figure 2.--The Canadian icebreaker LOUIS S. ST. LAURENT parallels the MANHATTAN's course and is ready to lend a helping hand on the historic trip through the Northwest Passage.

transporting natural gas from the rich source areas such as Prudhoe Bay and Pt. Barrow's Naval Petroleum Oil Reserve No. 4 to the United States and other temperate zone markets. One of these LNG carriers already has been built and made its maiden voyage from France to Boston in 1971. Studies are presently underway to determine the feasibility of a Surface Effects Vehicle (SEV) in negotiating polar pack ice.

Ice has been of concern to the mariner from sometime in the 4th century when the Greek navigator and geographer, Pytheas of Massilia first reported ice in the seas between Iceland and Greenland. The magnitude of this interest has varied widely and sporadically in the succeeding centuries. Knowledge of the nature and extent of the ice cover, and especially its wide time-space variability, has progressed at an extremely slow pace. Reliable estimates of the hemispheric volume of sea ice are just becoming possible as a result of recent rapid advances in space technology such as the polar orbiting weather satellites (fig. 3) together with parallel developments in electromagnetic, all-weather, all-season remote sensing equipment. It is presently possible to state only broadly

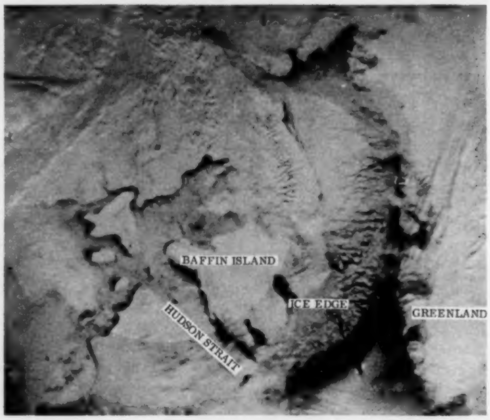


Figure 3.--Satellite picture of ice edge in Baffin Bay. Nimbus 3 photo, April 19, 1969.

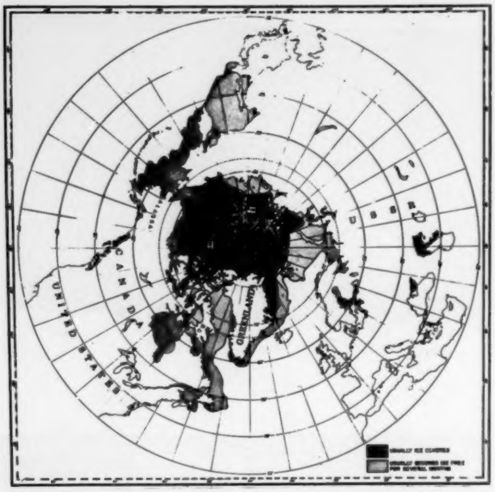


Figure 4.--Mean maximum and mean minimum limits of sea ice in Northern Hemisphere.

the mean areal extent of the ice-covered seas in the Northern Hemisphere. At their seasonal maximum, they comprise approximately 4.5 million sq mi in the April-July period; this area shrinks to some 2 million sq mi in the period of seasonal minimum coverage--usually during August to October (fig. 4). More detailed progressions of the annual variations in the outer ice edge may be found in various atlases published by the U.S. Naval Oceanographic Office, Deutsches Hydrographisches Institut, and Canadian Defence Research Board. The sporadic expansion in our knowledge of sea ice and related environmental variables progressed through the first half of the present century in direct proportion to arctic shipping activities. In this article we will examine the features and processes of the ice canopy which affect ship structures from the point-of-view of either surface or subsurface operations, design of marine terminal facilities, navigation through ice packs as well as trafficability over the ice surface.

In defining ice terms, an international working group on sea ice, within the World Meteorological Organization (WMO), has been attempting to standardize and unify for ice what for centuries has been a widely diverse nomenclature and definition system; basic adherence to this WMO nomenclature will be maintained in this article.

SEA ICE FEATURES AND PROCESSES

Any subdivision of ice types occurring in the sea must first differentiate between those originally forming and initially developing over land masses such as Greenland--glacial ice--or those having their origin and entire development in the sea itself or along its coastal periphery; this latter type is termed sea ice. After glacial ice is discharged or "claved" into the sea, the resulting fragments are further classified according to size type. Pieces the size of a city block or larger are called icebergs (fig. 5); those the ap-

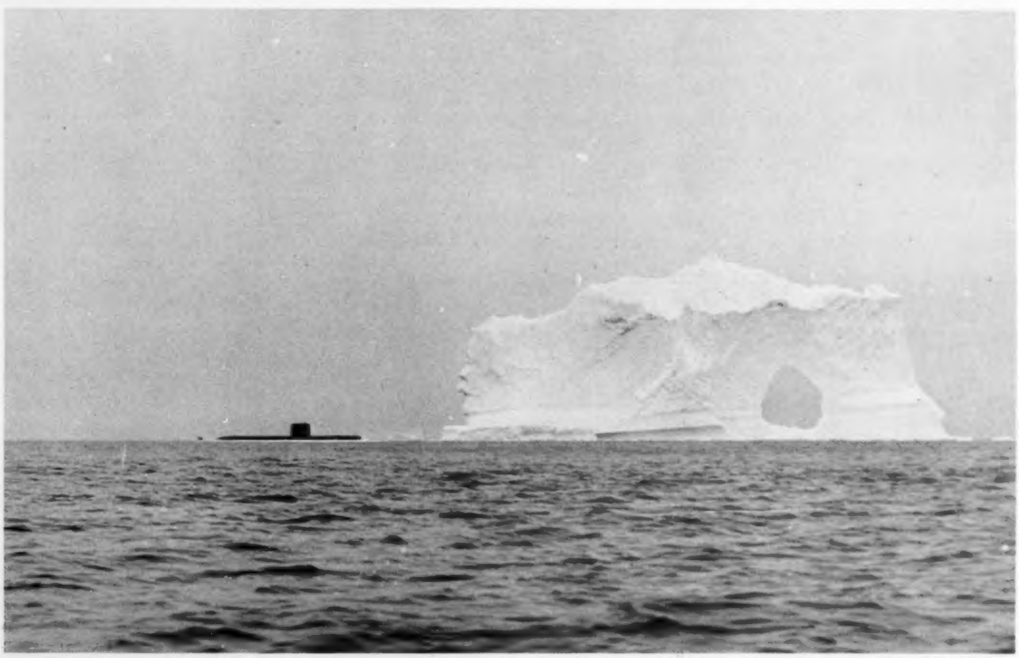


Figure 5.--Large iceberg (160 ft high) dwarfs submarine in northern Baffin Bay.

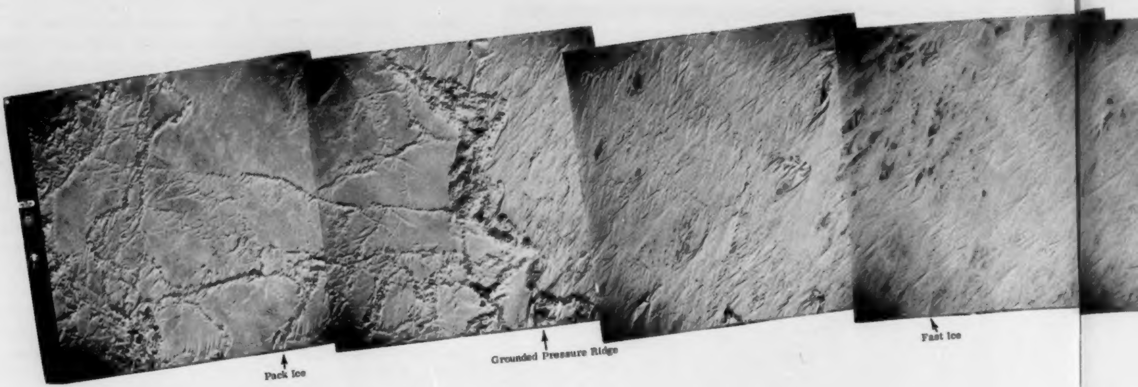


Figure 6.--Composite photograph showing coastline, fast ice, grounded pressure ridge, and pack ice north of Point Barrow. Distance from coastline to grounded pressure ridge is two-thirds of a mile.

proximate size of a small cottage are termed bergy bits, while piano-size chunks are referred to as growlers. Massive icebergs with the exotic, irregular pyramidal domed shapes, characteristically found in Greenlandic waters as well as in Baffin Bay and along the Labrador current, are usually rather easily identified and avoided by ships through the use of modern radar. However, one does not have to look back to the TITANIC for evidence of their danger. Danish ice experts believe the modern ice-strengthened HANS HEDGHOFF most likely met with disaster in an encounter with such ice when she abruptly disappeared on her maiden voyage in the vicinity of southern Greenland in 1959. Scores of growlers, in spite of their small size, can prove hazardous to shipping along such routes as the Port Churchill, Hudson Bay, transit through Hudson Strait into the Labrador Sea; this can be the case even in the absence of significant quantities of sea ice as is the situation from mid- or late-July through mid-November. When encountered in fog and heavy confused seas, they are indistinguishable on the radar scope.

Although dangers from icebergs are real and spectacular, the thousands upon thousands that have been recorded year after year since 1921 moving south of the 48th parallel, form only a minuscule areal coverage of the seas they infest. It is the ice that forms in the sea itself that dictates the special requirements of ship structure and marine architectural design. This applies to surface icebreakers, reinforced ships, under-ice submarine sails and superstructures, under-ice tanker barges, and other platform concepts presently under consideration, including those pertaining to surface effects vehicles (SEV) prototypes, which are presently being developed to traverse the rough ice canopies at speeds exceeding 85 kt.

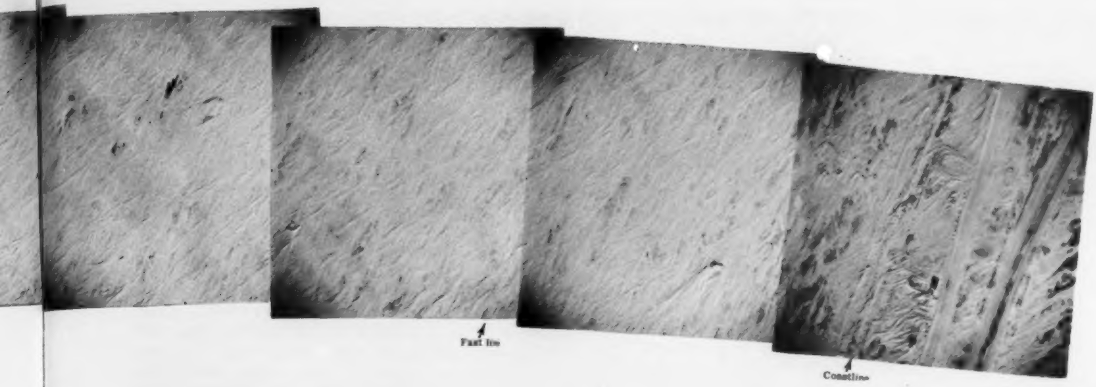
Sea ice must initially be divided into either of two categories. The first of these is that ice that forms from the shoreline and expands seaward after initial formation. This so-called fast ice (fig. 6) is relatively flat on its upper surface and is attached to the shore rigidly except for reactions to phenomena such as tidal oscillations and storm surges. Fast ice is generally confined to a coastal zone, extending seaward to, and more or less following, the 10-fathom isobath.

Drift or pack ice, on the other hand, tends to be characterized by a much rougher surface than that possessed by the fast ice. A further difference from the latter is its usual development into characteristic circular or ovate forms, during the early months of development. It is a result of deformation both at sea and along the shore that is caused by variable wind and current stresses, and ocean wave action. This fragmented ice is classified into size categories, varying in breadth from a few meters to miles. They tend to slowly rotate a few degrees a day--clockwise, when under atmospheric HIGHS, or anticyclones and counterclockwise if a LOW or cyclone is overhead.

The stage of development or age of the ice floe (or fast ice) is another of the most important characteristics of ice. It affects surface ship penetrability, submarine surfacings, bearing strength of ice runways for supporting the weight of heavy aircraft, or its ability to serve as a scientific drifting ice station.

Newly forming ice (fig. 7) is the first stage. The sub-types are too numerous to mention here, but are recognized in WMO and other ice glossaries by such terms as grease ice, slush, young ice, or gray-white ice. Maximum thickness attained is 30 cm; the ice has a grayish color, the younger the darker. It is usually smooth, and, when encountered in midwinter it tends to be elastic and very saline compared to other sea ice--the latter is true because the salinity of the ice depends on the rate of freezing; i.e., the more rapid the freezing, the more saline the resulting ice. The growth rate of ice decreases with thickness because of a decrease in the rate of heat conduction from the water to the atmosphere. Strength of these new ice types, as well as the subsequent stages discussed below, is highly dependent upon the sea ice temperature. The relationship between strength and salinity is complex and nonlinear. At -7°C the sodium sulfate crystalizes and at -23°C the sodium chloride solidifies; below -23°C, saltier ice actually has greater tensile strength than the less saline ice.

The second major stage of development, or age,



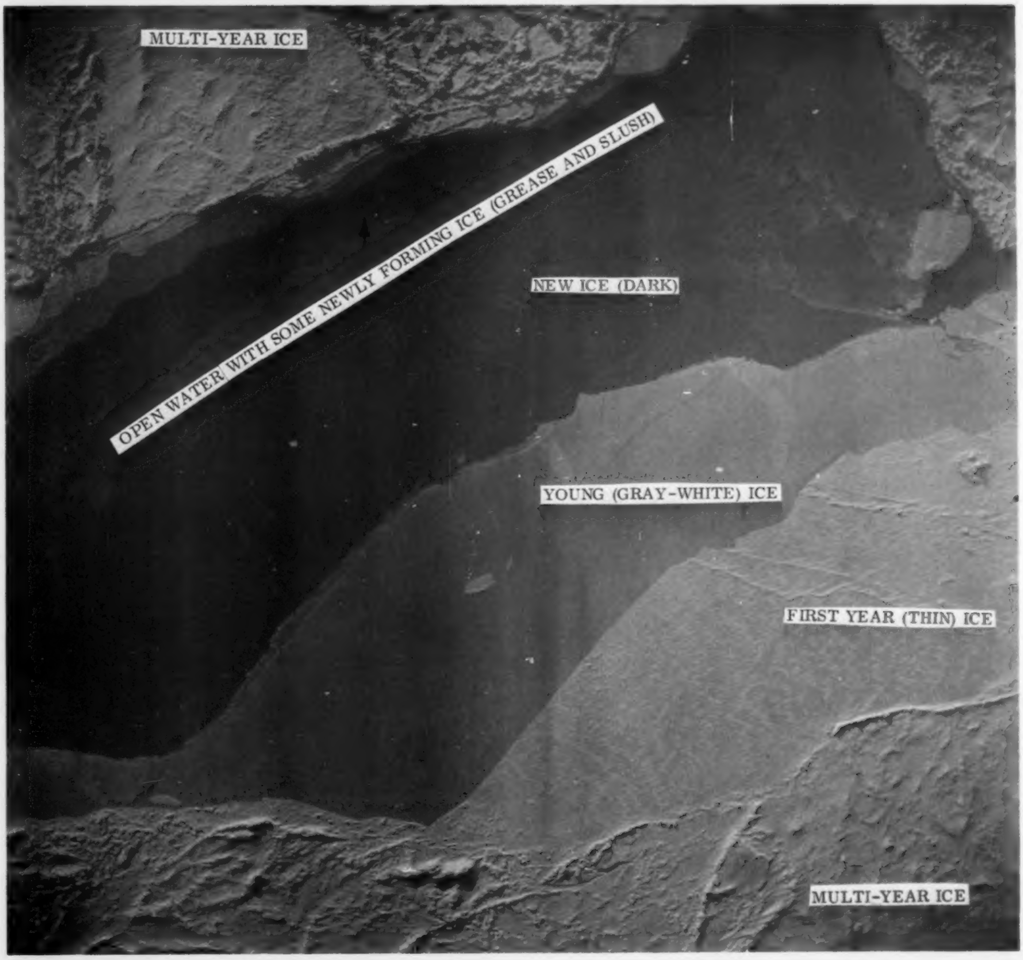


Figure 7.--Several stages of development occuring in Arctic Pack Ice.

reached by ice which has a sufficiently long growing season, is first-year ice (fig. 7). WMO sets a lower limit of thickness of this stage at 0.3 m. It can hypothetically attain any maximum thickness, but the prevailing minimum annual air temperatures result in first-year ice rarely, if ever, exceeding a thickness of 2 m. First-year ice is usually whitish in color and is interspersed with steep, new pressure ridges or roughness features. It cannot, by definition, have survived a melt season.

A third stage is ice that has not completely melted during an arctic summer and begins a new growth cycle in the second year. It is termed second-year ice: after surviving two summers, the ice is called multi-year (fig. 7) or old ice. Such ice is frequently bluish in color. Its topography is more rounded, more weathered, and more undulating than first-year ice. Old ridges are discernable within the multi-year ice but tend to be much lower in height; their slopes are more gentle and their bases wider than is the case of new ridges associated with first-year ice.

Roughness features of sea ice, or ice topography, are a prime deterrent for almost any modern ship or SEV structure. The multi-year floe is subject to a limiting thickness of approximately 3 m. The thicker that ice grows, the slower its growth rate; on the other hand, approximately 0.6 to 1.3 m., depending on severity of the season and locale, are eroded each year during the summer melt season. As a result, although multi-year ice floes can, hypothetically, circulate forever in closed circulations that characterize the Arctic, they are renewed by this process of alternate annual growth and melt after approximately 3 yr. Pressure ridges (figs. 8 and 9), caused by shearing motion within the pack ice, alternate rarefaction and convergence, or by compression against shoal areas containing grounded ice or shorelines result in total thickness varying considerably. A maximum thickness for pressure ridges appears to be 45 m. This occurs in areas of 6 m average thickness. These ridges appear to have an above-to-below water ratio of between 1:3 and 1:5, although recent work near the U.S. Drifting Ice Station T-3 suggests 1:7 in the vicinity of heavily compacted multi-year ice. Base of these ridges vary from tens of yards to a few hundred yards.

Shearing or more often tensile fractures frequently occur when the wind, ocean current, coriolis, water resistance, and ice resistant forces act on the pack ice. If these openings are long and narrow, they are termed cracks; if they widen with little change in basic orientation, they are termed leads (fig. 10); if ovate or circular isolated openings form, they are termed polynyas (fig. 10). As a result of the continual stress operating within the ice packs, individual floes drift at average rates of 2 or 3 mi per day; extreme motion of 30 mi or more per day has been reported during and/or shortly after severe storms. Add to this the floe rotation, already noted above, and occasional inertial loop meanderings with periodicities of 12 hr or so, and an idea of the extremely complex motions within the pack ice emerges.

The ice edge (fig. 3) is the demarcation at any given time between the open sea and sea ice of any kind. It may be compacted when subjected to onshore winds; offshore winds, on the other hand, produce a diffuse

Figure 8.--Ten-foot pressure ridge at North Pole, May 1969.

Figure 9.--A fish-eye view of an underwater arctic ice pressure ridge, taken by the submarine SEADRAGON.

boundary, as would be expected. For the term boundary, WMO usage dictates a connotation differing between types of ice, e.g., the boundary between fast and drift ice or the boundaries between ice having differing concentrations and densities. Pack ice that totally covers the entire sea surface with no open water is consolidated or compact; 7/8 coverage with 1/8 open water is very close, 6/8 to less than 7/8 coverage is close, 3/8 to 6/8 is open, 1/8 to less than 3/8 is very open, less than 1/8 is open water, and, finally, if no sea ice is present, the term ice free is recommended (icebergs or fragments thereof may or may not be present). The various amounts of coverage are shown in figure 11. Many other ice terms exist that in particular cases may be of importance to the shipping community.

Snow cover greatly affects icebreaker penetrability, especially near the melt season, when occasional above freezing surface temperatures may cause that snow to be especially dense. The percentage of ice covered with puddles (fig. 12) or thaw holes and whether these vertically penetrate the ice to permit water drainage is another factor; this weakens ice floes and generally eases ship penetrability.

All terms defined in the paragraphs immediately above have been considered on a scale such as could be seen from an icebreaker's crow's-nest, by observers reporting from a helicopter or aircraft platform or from an elevated shore station. Several much larger scale features of ice distribution in the Arctic Basin and its marginal seas are also deserving of consideration. Of major interest and importance are the

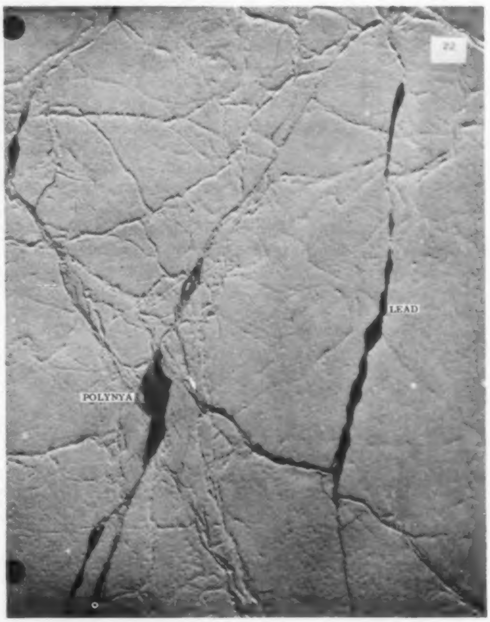


Figure 10.--Water features within pack ice.

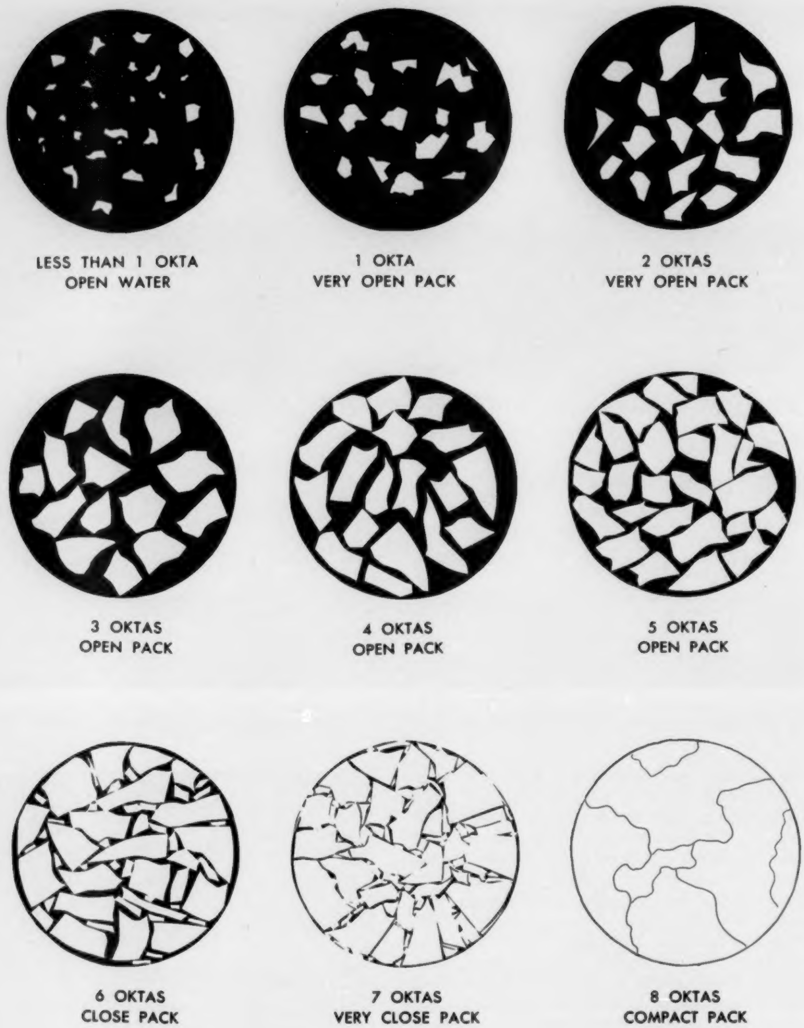


Figure 11.--Schematic of varying ice concentration.

large-scale recurrent, quasi-open polynyas and leads. These remain largely free of thicker and/or densely concentrated first-year or multi-year ice types in spite of air temperature regimes with 3 consecutive mo of -30°C or lower mean monthly temperatures and where the vertical density structure is stable and conducive to significant ice growth. The so-called North Water or North Open Water in Smith Sound, the northern extremity of Baffin Bay, is perhaps the best known of these features. Here, a region, of more than 1,000 sq mi in area, remains free of significant quantities of old and first-year ice in the January through March period. Thereafter, this quasi-open condition expands southward and westward into Parry Channel; by June, it merges with a second open water area in the Barrow Strait area of Parry Channel, attaining at this time an area covering tens of thousands of square miles. Although still far from adequately understood, this anomalous condition is believed to result primarily from ice being constricted in its normal north to south drift in the North Water and from its normal west to east drift in Barrow Strait of Parry Channel. The constriction is attributed to a funnelling effect of the ice by geographic configurations and by islands and shoaling water in the vertical. Thus heavy concentrations of old and first-year ice totally cover or jam the constrictions, and prevent further downstream flow. On the contrary, new and young ice types forming downstream thereafter are constantly removed before they are able to attain the first-year or later sea ice growth stages. Other such phenomena are found along the north coast

Figure 12.--Lead stretches to the horizon as vessel veers to starboard in rapidly deteriorating puddled ice.

of Hudson Strait, in northern Foxe Basin, and between Banks Island and Cape Bathurst on the northern Canadian mainland. Another recurrent lead similar to the others and having dimensions of 10 to 50 mi wide and frequently more than 1,000 mi long (generally oriented east-west) is repeatedly evident on the new weather satellite imagery. The lead is located to the north of the major Archipelagos of the Eurasian Arctic Seas where the prevailing drift carries ice away from its source region.

Certain large-scale circulatory features can be discerned in virtually all of the marginal seas of the North American Arctic. On the west side of every major island--be it Greenland or a smaller island such as Spitzbergen or Novaya Zemlya--there will be a relatively warm current flowing with a predominantly northward component. On the east side, a southward component predominates with relatively cold, ice-carrying water. This tends to result in the corollary phenomenon that nearly every marginal sea, Eurasian Arctic as well as North American, is characterized by a counterclockwise circulation.

In the central Arctic Basin--its ice cover sometimes referred to as Arctic Pack or Arctic Pack Proper--two circulatory features predominate (fig. 13). First, a broad clockwise circulation exists north of Alaska and the western portions of the Canadian

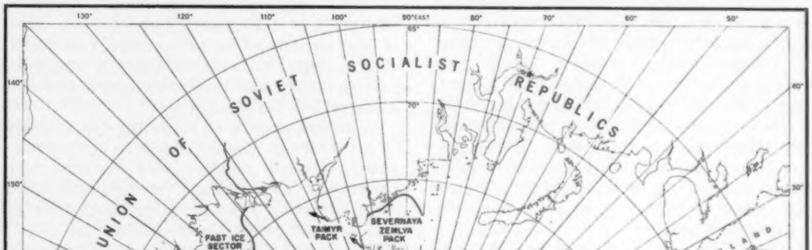


Figure 13.--Major drifts of polar ice.

Archipelago, stretching northward to the Lomonosov Ridge. This submarine ridge divides the Arctic Basin roughly in half (into the Canadian Basin on the Pacific side; the Nansen Basin on the Atlantic side), extending from the northernmost tip of Canadian territory across the Geographic Pole to Severnya Zemlya north of the Severnyain Mainland. Several of the 21 Soviet, as well as several United States drifting ice stations have followed this meandering clockwise movement known as the Pacific Gyral or Gyre.

The second major Arctic Basin feature is the Trans-Polar Drift. In its northward movement, it borders, and/or coincides with, the Pacific Gyral between the area north of the Chuckchi Sea waters, between Wrangel Island and the area north of Point Barrow, Alaska, and stretching to the North Geographic Pole. In this region, however, as the Pacific Gyral turns toward Canada, the Trans-Polar Drift continues more or less directly southward toward the Greenland Sea and beyond--paralleling the entire east coast of Greenland. If an ice floe in this trajectory has not melted after reaching 70°N in the vicinity of Scoresby Sound, and this is only if it attains this position in the August to November time frame, then it will continue in its drift rounding Kap Farvel. It can continue some 100 to 200 mi further to the north-northwest before disintegrating under the influence of warm waters and wave erosion. These major circulation features may have serious impact a decade or so from now when serious consideration is given to the design of platforms that may carry oil or other products directly through or beneath the Arctic Pack, taking advantage as they do of the favoring currents, ice drift, and winds. These major drift features have been consistently documented with average monthly speeds of 1 to 3 mi/day. North of Alaska and the East Greenland drift stream, single day movements of up to 48 mi have been recorded on rare occasions; however, it must be stressed that these patterns are very unstable.

Finally, a feature that cannot be neglected is one that has been recognized from the days of the earliest sailing vessel that has had direct contact with very close, compact, or consolidated ice. This is ice under pressure, or pressure in the ice, or simply pressure. This is also a process as yet not fully understood. When pack ice is subject to deformational processes, it occasionally results in stress within the ice, impeding or endangering shipping--in the former case, by reducing forward rate of advance or causing them to be completely stopped, or beset; in the latter case, by crushing the hull or components thereof. For the first time, quantitative empirical data relating winds, distance from coast, etc., to pressure, as expressed by the rate of closing of a ship's wake, have been acquired. These data tended to confirm that near coasts, pressure is more likely to occur with onshore winds and that the general frequency of occurrence of pressure and its severity is indeed directly proportional to wind speed.

CURRENT RESEARCH

Up to the 1930's, research efforts by both the United States and Canadian government activities relied heavily on work reported by the prolific U.S.S.R. scientist N. N. Zubov. From that date, most of the research and developmental effort concerned with observation and prediction of ice behavior has proceeded in two distinct channels in the western world. First, airborne and satellite sea ice imagery interpretation techniques have developed rapidly. A great deal of assistance in this area resulted from the NASA Earth Resources Applications project. Such satellite sensors as Vidicon cameras and high-resolution infrared radiometers (IR) are providing better sequences of data, showing changes in ice edge and the broader changes, when they occur, in ice concentration. The IR is now providing such broad scale data during the 3 mo of polar darkness. Sensors tested from aircraft, which include IR scanners that provide thermal imagery, permit the interpretation of many more thickness categories than could be gleaned from visual photographs. The optical laser has yielded low-altitude two-dimensional profile data sequences of ice roughness to better than 1-ft accuracy. Pilot studies have been completed in the areas of side-looking radar and passive microwave. The latter sensors are all-weather.

A second area is in modeling the heat loss from ice to air through the point where heat convection in the water column ceases, ice formation occurs, and growth proceeds. These "ice potential" models permit the prediction of formation and growth in varying temperature and salinity conditions.

Not until 1970, however, were serious modern attempts made to increase our understanding of the drift and deformation processes so important to ice behavior, as it affects all possible operations within the ice canopy. This knowledge is vital for surface and submarine operations and for the construction of offshore terminals for marine exploitation of arctic oil. In 1971, 1972, and 1973 Project AIDJEX for Arctic Ice Dynamics Joint Experiment, conducted pilot experiments. These joint air-ice-sea simultaneous studies together with careful measurements made on several spatial scales and with airborne and satellite imagery promise to exponentially increase our knowledge and predictability of the Arctic Sea ice canopy by 1980.

GREAT LAKES - ST. LAWRENCE SEAWAY NAVIGATION SEASON EXTENSION

Detroit District, Corps of Engineers
Detroit, Mich.

The Winter Navigation Board, a multiagency organization, has initiated a "Winter Navigation Program" to study and test the feasibility of means to extend the navigation season for the Great Lakes and St. Lawrence Seaway. The ultimate objective is to determine the possibility of guaranteed year-round navigation. Even limited success in extending the navigation season should have a definite economic impact in the Great Lakes area.

The recently completed season has demonstrated the practicability of extending the navigation season. New records were achieved in the extended season just completed. Commercial navigation through the Soo Locks and the St. Marys River lasted until February 8--7 days longer than last year. It carried 3,363,000 tons of cargo--a 70-percent increase over last year's extended season tonnage. The last downbound vessel to clear the Soo Locks was the freighter A. H. FERBERT.

The new season opened 2 days earlier than usual, with a record-breaking opening date of March 28 for the St. Lawrence Seaway, when the DAVID MARQUESS locked through.

GOALS

The "Winter Navigation Program", as authorized by Congress, is comprised of 1) a 3-yr action program aimed at demonstrating the practicability of extending the navigation season and 2) a survey study to determine the feasibility of means of extending the navigation season for the Great Lakes and St. Lawrence Seaway.

Features of the demonstration program include ship voyages extending beyond the normal navigation season; observation and surveillance of ice conditions and ice forces; environmental and ecological investigations; technical data related to improved vessel design; ice control facilities and aids to navigation; physical model studies; and the coordinated collection and dissemination of information to shippers on weather and ice conditions. The survey study is designed to determine the economic, environmental, and engineering impacts of extending the navigation season for the entire Great Lakes-St. Lawrence Seaway system.

The ultimate goal of the entire Program is to demonstrate and investigate the practicability of guaranteed year-round navigation, while at the same time minimizing any adverse effects that such an undertaking may engender.

AUTHORITY FOR THE PROGRAM

Congress and the President authorized the program in the River and Harbor Act of 1970 (Public Law 91-611), which directs the Secretary of the Army, acting through the Chief of Engineers, to undertake the demonstration program and survey study. The demonstration program is in cooperation with the Departments of Commerce, Interior, and Transportation; the Environmental Protection Agency; other interested Federal agencies, and non-Federal public and private interests. To carry out the 3-yr demonstration program, the Act authorized expending of $6.5 million. A report on the results of the demonstration program will be submitted to the Congress in July 1974. A more detailed survey study report will be completed at a later date and will contain recommendations on the advisability of Federal participation in any guaranteed extension of the navigation season.

PARTICIPATING AGENCIES

The program is directed by the Winter Navigation Board, a multiagency organization (fig. 14) which includes representation by Federal and non-Federal public and private interests. The Board is composed of representatives from the Corps of Engineers, Coast Guard, St. Lawrence Seaway Development Corporation, Department of the Interior, Maritime Administration, National Oceanic and Atmospheric Administration, Federal Power Commission, Environmental Protection Agency, Great Lakes Commission, and Great Lakes Basin Commission. An Advisory Group to the Board has been formed to provide input from industry, labor, consumers, and concerned citizens. An observer from the St. Lawrence Seaway Authority of Canada is also included in the Board Structure, as well as technical advisors representing the Atomic Energy Commission and the National Aeronautics and Space Administration.

A Working Committee, similarly constituted, carries out the program activities approved by the Board. "Lead agencies" are responsible for carrying out activities under each of seven functional categories, as follows:

Ice Information, (National Oceanic and Atmospheric Administration); Ice Navigation, (Coast Guard); Ice Engineering, (Corps of Engineers); Ice Control, (St. Lawrence Seaway Development Corporation); Ice Management in Channels, Locks and Harbors, (Corps of Engineers); Economic Evaluation, (Corps of Engineers); and Environmental Evaluation, (Environmental Protection Agency).

ACTION-WINTER, 1971-72

There was significant progress during the first year of the program.

Navigation continued through the Seaway until December 20, an extension of 6 days beyond the previous year.

The navigation season for the Soo Locks was extended into February for the first time in the history of commercial navigation.

During this first year of the program, emphasis was placed on Ice Information and Ice Navigation ef-

Figure 14. --Participating agencies in the Winter Navigation Board.

forts, as a basis for future program activities. Major program activities accomplished during the winter of 1971-72 included:

1. Expansion of the Ice Navigation Center's operations to provide daily reports to vessels on weather and ice conditions. (The Center is operated by the Coast Guard in conjunction with the National Weather Service.)

2. Aerial and ground surveillance activities of ice conditions, ice movements, and ice effects on water levels and shore properties.

3. Development and design of ice anchoring and stabilizing structures including a gate for a St. Lawrence River ice boom to facilitate winter navigation without disrupting river flow.

4. Field testing of various marine navigation systems for accurate location of ships operating in ice-covered channels. Also, tests on the Coast Guard Cutter RARITAN of a new system for reducing ice friction on a vessel hull, as well as testing of lighted ice buoys and light structures.

5. Installation by the Corps of Engineers of a special air-bubbling system at the Sugar Island ferry terminal on the St. Marys River (near Sault Ste. Marie, Mich.) to provide dependable ferry service for residents of Sugar Island throughout the Extended Navigation Season. Additional support for the ferry operation was provided by the Coast Guard when accumulating ice and adverse weather blocked ferry passage.

6. Operation of a bubbler system at Lime Island Turn, St. Marys River, which successfully eased vessel operation around a difficult turn in the ice field.

7. The Maritime Administration initiated tests of a shipboard navigation system based on the laser-radar principle.

ACTION-WINTER, 1972-73

The navigation season for the Soo Locks was ex-

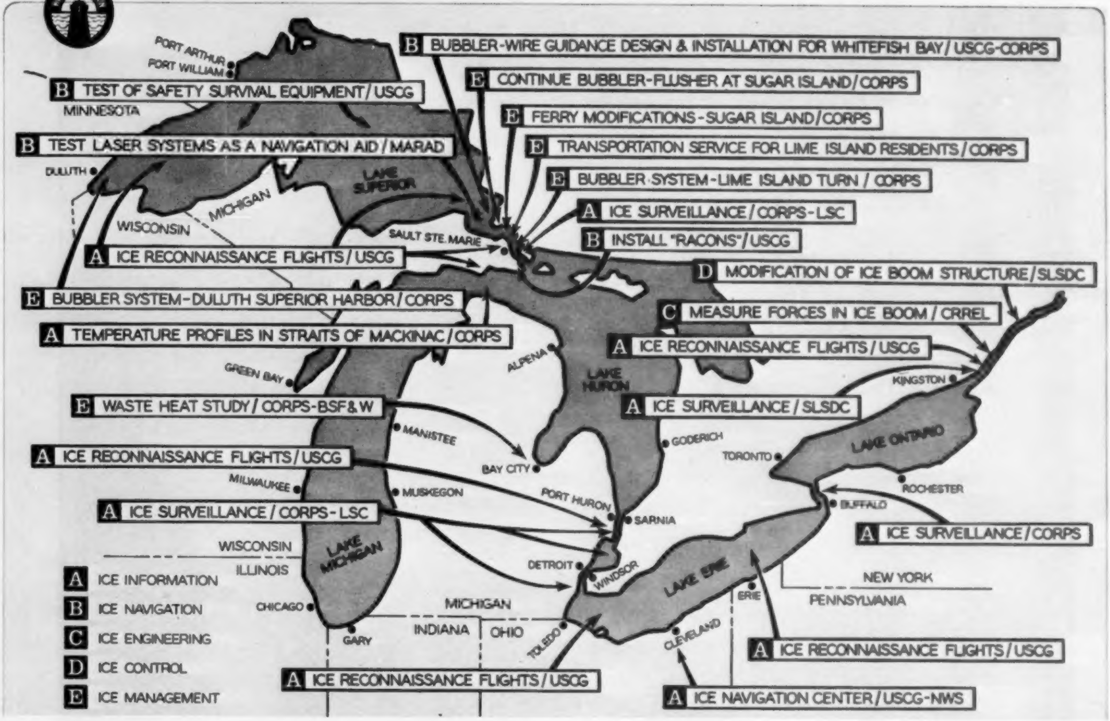


Figure 15.--Winter activities, 1972-73 for the Great Lakes-St. Lawrence Seaway Navigation Season Extension.

tended to February 8, breaking the old record of 1972 by 7 days. The last ship using the St. Lawrence Seaway was the HUDSON TRANSPORT which locked through on December 23, an extension of 3 days beyond the previous season.

Mild weather, greatly increased icebreaking efforts, and very close coordination between Federal authorities and the users this spring brought about the earliest opening of navigation since 1959. The Soo, the Welland Canal, and the Seaway all opened for commercial traffic on March 28, 1973. The winter activities for the '72-'73 season are shown in figure 15.

Ice Information

1. Daily reports and ice forecasts were provided to vessel operators on weather and ice conditions via the Ice Navigation Center in Cleveland.

2. Aerial and ground surveillance activities were conducted on ice conditions, ice movements, and effects on water levels and shore properties. Emphasis was given to connecting channels. Time lapse photography was used in the St. Marys, St. Clair, and Niagara Rivers to document ice movements and ship passages.

3. Short-term ice development forecast techniques are continuing for the Great Lakes. Methods for long-range prediction of freeze-up dates will be developed.

4. Effects of vessel passages on selected shore structures and shorelines were monitored.

5. Water flow, velocity direction, levels, and temperatures, as well as ice thickness, were measured.

Ice Navigation

1. Precautions to ensure the safety of seamen in late season sailings has resulted in a series of expanded tests of survival suits and equipment.

2. Design of a combination air-bubbler-wire guidance navigation aid was completed.

3. Radar Transponder Beacons (RACONS) were reinstalled in the St. Marys River; existing aids to navigation received reflective paint enhancement.

4. Large buoys were tested on the St. Marys River.

5. The Maritime Administration continued tests and evaluations of an advanced shipboard navigation system based on a combined Laser-Radar

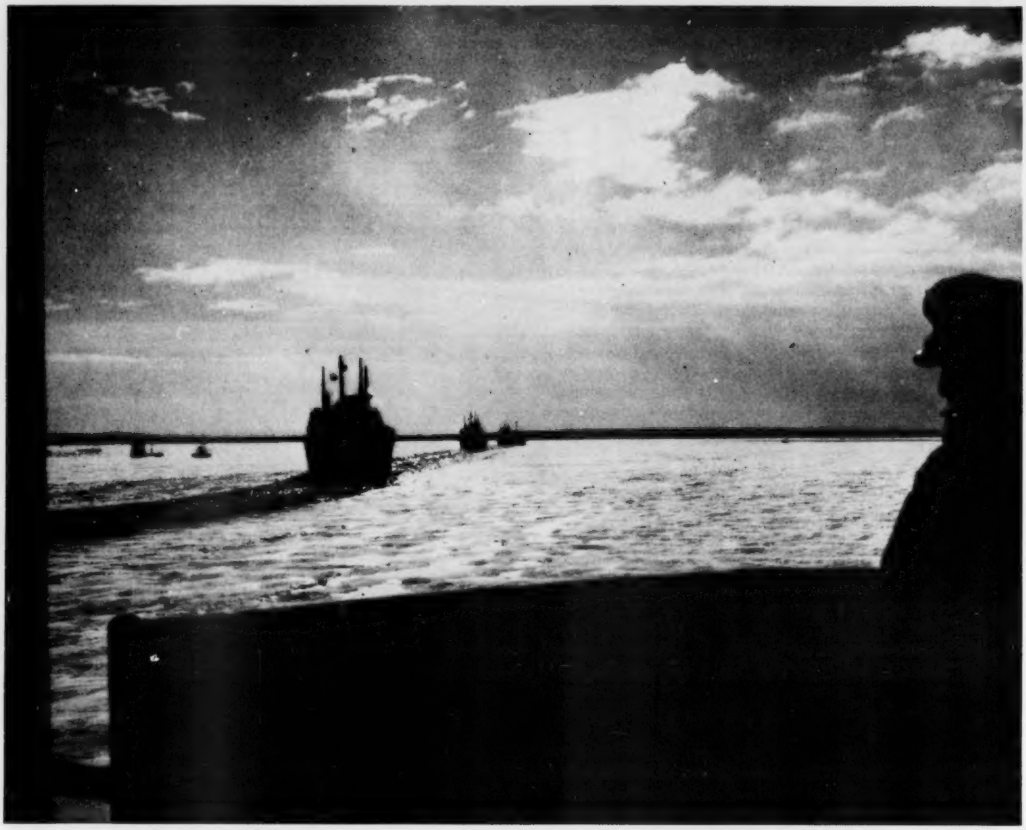


Figure 16.--Silhouette photo of a wintry convoy as the Coast Guard Icebreaker MACKINAW leads the way for several freighters on Lake Michigan.

system.

6. Additional nonstandard operational aids to navigation were tested.

Note: The Coast Guard, under its ongoing program, added the icebreaker SOUTHWIND, of the polar type, to Great Lakes duty to assist the MACKINAW (fig. 16), a veteran of freshwater ice breaking.

Ice Engineering

1. Determination will be made of ice forces on the ice boom structure in the St. Lawrence River.

2. Field studies were conducted in the St. Lawrence River to determine results of ice forces on shore structures.

3. In eastern Lake Erie installations were made to determine the effects of vertical and horizontal ice forces on pilings.

Ice Control and Management

1. A gate was installed in the ice boom across the St. Lawrence River, at Ogdensburg, N.Y., to test the acceptability of a gate in an ice boom structure and its effects on the river's ice cover and the resulting river flow.

2. Modifications to the Sugar Island ferry have been completed to increase ice operating capability. This assured the same degree of reliable transportation that existed for the Sugar Island residents prior to the Demonstration Program. The air-bubbler has also been re-installed to provide dependable docking conditions for the ferry. Additional support for the ferry operation was furnished by the Coast Guard, as required.

3. The Corps of Engineers will conduct a season extension systems study on the St. Clair River, Lake St. Clair, and the Detroit River complex. The St. Lawrence Seaway Development Corporation will conduct similar studies on the International Section of the St. Lawrence River.

4. New and existing bubbler systems underwent further tests and evaluations. The 3,000-ft air-bubbler at the Lime Island Turn, St. Marys

River which successfully operated last year was tested for continued operation capabilities.

5. An air-bubbler system was installed at Duluth-Superior Harbor.

6. The Saginaw River was selected for future tests to determine the effectiveness of waste heat, from thermal power plants, in reducing ice cover thickness. This year's activity includes collecting baseline environmental data and site evaluation by the Bureau of Sport Fisheries and Wildlife, the State of Michigan, and the Environmental Protection Agency for use in determining environmental impact.

Environmental Evaluation

1. Assessments by the Environmental Protection Agency and others of adverse or beneficial environmental impacts observed from monitoring program actions continued. These assessments are considered in evaluating future proposed actions.

2. Environmental Protection Agency, Bureau of Sport Fisheries and Wildlife, Bureau of Outdoor Recreation, National Oceanic and Atmospheric Administration, Lake Survey Center, and Corps of Engineers are continuing their programs to develop baseline environmental data.

Economic Evaluation

Collection of costs and effectiveness data pertaining to all program activities continued as will the analysis of economic data of the extended season operations.

CONCLUSIONS

Season extension on the lakes is a reality today, but greater traffic is important to its long-range viability. Increased ship movement and resultant benefits are needed to justify an extended season on a permanent basis. The successful experience on the Lakes thus far will be an important factor in sustaining the efforts to solve the major engineering problems involved in season extension on the St. Lawrence Seaway. The efforts are mutually supporting and are most appropriately combined in a single program to demonstrate winter navigation on the Great Lakes and St. Lawrence Seaway system.

GREAT LAKES NAVIGATION SEASON, 1972

Elwyn E. Wilson
Environmental Data Service, NOAA
Washington, D.C.

The 1972-73 navigation season on the Great Lakes opened on the programed date of April 1, 1972. The original announced opening date was initially postponed to April 5, but later revised back to April 1. The 27-mi Welland Canal was opened on March 29, 1972, for the shortest shutdown period on record--80 days. The past season had closed on January 8, 1972, the latest closing date for the Canal. Initial transits through the Canal were delayed as icebreaker assistance was required. The first ship through the Welland Canal, both downbound (April 3-4) and upbound (April 5), was the 730-ft TADOUSSAC with a load of coal.

The St. Lawrence Seaway navigation season opened on April 12. This was 2 days earlier than last year, but the first westbound passage from Montreal to Lake Ontario was not completed until the 16th. Passage was hindered by 20- to 30-in. thick ice in a number of areas along with below-normal temperatures. The ice over a large portion of the Gulf of St. Lawrence was reported to be the most extensive in 15 yr. Ocean vessels encountered shore-to-shore solid ice cover before reaching the Seaway. The first ocean vessel into the St. Lambert Lock, at Montreal, was the OLAU SYD, a 463-ft Danish tanker on the 12th. She also was the first overseas ship through the Welland Canal on the 17th. At the west end of the Seaway, the Canadian freighter, ALGOCEN, made the initial eastbound passage through the Iroquois Lock. The large number of westbound vessels and icebreaking operations delayed the ship in clearing the Seaway at Montreal until the 18th. Navigation was limited to daylight hours only, until the 27th, when conditions permitted the installation of all floating navigation aids.

The Soo Locks were placed in operation on April 1 but did not handle their first interlake traffic until the 10th--later than 1971 by 2 days. The first ship through was the WILLIAM CLAY FORD, followed by the ore carrier, JOHN DYKSTRA. Both arrived at Duluth-Superior on the 12th. Coast Guard icebreakers and cutters saw heavy service in the early weeks due to windrowed ice on the upper Lakes. The first ocean vessel through the Soo Locks was the Norwegian STOVE CALEDONIA, on April 21.

Navigation in the lower Lakes had started a month earlier, on March 1, when the BENSON FORD departed from Detroit for Toledo. On the 18th, the S. T. CRAPO left Detroit to be the first ship northbound. The icebreaker MACKINAW led the J. A. W. INGLEHART and the S. T. CRAPO through the Straits of Mackinac on March 28. It was not until mid-May that all the Lakes were ice-free.

Last year, the Poe Lock closed on February 1, 1972. The BENJAMIN F. FAIRLESS and the ENDERS M. VOORHEES were the last ore boats to transit the Lock. The ships were then assisted by the icebreakers MACKINAW and EDISTO (cover). Shipping ended on February 7, 1972, except for ferries and a few ships in the lower Lakes.

This season, the Canadian Lock closed on December 12, 1972 and the three U.S. Locks, except for the new Poe Lock, were closed on the 23d. The 1972 shipping season ended in the upper Lakes on February 8, 1973, for the longest season on record--310 days, when the

Poe Lock closed.

Record late passages were made through the St. Lambert Lock near Montreal to close the 1972 Seaway navigation season. The Canadian HUDSON TRANSPORT made the final transit on December 23. She was also last in 1971 on December 20. The last ocean freighter was the Liberian TRIAS, which passed through the Lock on the 22d, extending the previous record by 3 days.

The Welland Canal closed as scheduled, on December 15, 1972, for completion of a bypass channel. The last passages along the old route were made by the Canadian freighters, TADOUSSAC (upbound) and the PIC RIVER (downbound). The last ocean ship, the Cypriot ELTHINA, passed downbound on the 15th.

The 1973 season opened ahead of schedule, on March 28, 1973. The early opening applied to the Montreal-Lake Ontario section, Welland Canal, and the Soo Locks.

Recent articles in the Mariners Weather Log on Great Lakes and Seaway ice appeared in Vol. 16, No. 3; Vol. 17, No. 1; and Vol. 17, No. 2.

NOAA NATIONAL WEATHER SERVICE AIDS, 1972

Full weather services were provided to shipping from April 1, 1972, until early February 1973. Generally above-normal temperatures throughout the lakes region, in January, allowed extended-season navigation beyond the record date of February 7th, set during the 1971-72 season. National Weather Service Forecast Offices in Chicago, Detroit, and Cleveland continued to provide the backbone of marine services. Synopses and coded open water forecasts (MAFOR) including gale and storm warnings were prepared every 6 hr and broadcast by marine radio stations at Duluth, Port Washington, Chicago, Rogers City, Lorain, and Buffalo. Plain language forecasts were also prepared and disseminated every 6 hr by the three forecast offices. Near shore forecasts were issued three times per day by 15 Forecast and Weather Service Offices around the Lakes system.

Twenty-one Coast Guard radio stations made special safety broadcasts of gale and storm warnings on receipt, as well as Special Marine Warning Bulletins, Severe Weather Warnings, Watches and Statements, and Lake Surge Statements. Radio stations at Belle Isle, Buffalo, and Milwaukee also made routine broadcasts of weather and marine forecasts and observations every 2 hr. Station Marblehead made similar broadcasts hourly, and Sault Ste. Marie made broadcasts at 1300 and 1900 daily.

A total of 329 gale warnings were issued for calendar year 1972. This was an increase of 125 over the previous year. Storm warnings totaled 37--an increase of 12 over 1971. Special Marine Warning Bulletins issued for short-fuse weather hazards, such as thunderstorms and heavy fog, totaled 178.

Marine Radio Station WMI in Lorain, Ohio, continued to broadcast the Great Lakes Weather Broadcast (LAWEB) every 6 hr. Coast Guard shore observations and both Canadian and United States ship weather reports are combined with additional data from around the Lakes by the Cleveland Weather Service Forecast Office. The National Weather Service continuous VHF weather broadcasting system was expanded during 1972 with the addition of facilities in Detroit and Milwaukee. This completed the VHF plan for Lake Erie.

Funding through the Demonstration Program to Extend the Great Lakes Navigation Season under the management of the U.S. Army Corps of Engineers allowed an expansion of service with the appointment of a National Weather Service meteorologist to the Coast Guard Ice Navigation Center in Cleveland. See story on page 135 of this issue. A newly dedicated teletype network linking the Weather Service, the six marine radio stations, the Coast Guard Ninth District Headquarters, and the Canadian Atmospheric Environment Service was placed in operation on January 16, 1973. The new network provides rapid dissemination of weather and ice information through the Lakes system. The network is open to nongovernment subscribers at their own expense.

GREAT LAKES ICE, 1972

A discussion of the 1971-72 ice season by George D. Linklater, National Weather Service, Detroit, appeared on page 15 of the January 1973 issue of the Mariners Weather Log.

Ice formation on the Great Lakes was generally quite late due to mild weather which persisted well into December 1971. Navigation proceeded unassisted until the latter part of January 1972. The late freeze-up was a boon to late season operations which were officially underway for the first time under the Demonstration Program to Extend the Great Lakes Navigation Season.

Outlooks for winter freeze-up were issued by the Detroit Weather Service Forecast Office on November 17 and December 1, 1971. Regular ice advisory service was initiated on December 15, 1971. The first vessel to experience difficulty in the ice was the BENJAMIN F. FAIRLESS, which was beset briefly in the St. Marys River, on December 31. Aside from the usual movements of tankers and car ferries and a few ships between Detroit and Toledo with coal, shipping ended on February 7, 1972. This was the longest season on record.

Although ice conditions remained quite poor through early March, navigation resumed in the upper Lakes, by late in the month. The St. Marys River was opened on April 7, and Whitefish Bay the following day. The St. Lawrence Seaway opened in March, and the Welland was opened April 3. A cold spring retarded the ice melt and difficult conditions lingered through early May in the upper Lakes. Northeasterly winds plagued navigation during the period by jamming the ice into the south and west sections of Superior (fig. 17) and the southern sections of Huron, as well as shipping channels in the Straits of Mackinac and the Soo waterway. It was not until mid-May that all of the Lakes were clear. Ice Advisory Service from the Detroit Weather Service Forecast Office was terminated on February 15 and resumed again on March 1, 1972. Outlooks for opening of navigation were prepared on March 6 and 27. The last Ice Advisory of the season was issued on May 10, 1972. Table 1 is a summarization of the March 6, 1972 outlook.

Ice was responsible for a number of ship casualties on the Great Lakes and the St. Lawrence River. Most of them were in the Gulf of St. Lawrence, as were the following. The 10,149-ton British MANCHESTER QUEST, out of Montreal, put into St. John's on February 13 with hull damage and one hold flooded due to contact with ice. The Finnish motor vessel MARGARETA (2,605 tons) was icebound on February 28. The 14,088-ton Greek motor vessel KOSTIS PROIS became icebound on March 13, inbound on the St. Lawrence River. On March 29, the Liberian motor

Figure 17.--Late ice still remained in the Superior-Duluth Harbor Basin in early June. However, freighters had no trouble, as the French bulk carrier CHRISTINE proved on entering Duluth. Wide World Photos.

Table 1--Forecast and actual opening dates for various waterways, spring 1972. Vessel involved is shown when known.

Area	Icebreaker	Natural	Actual	Vessel
Duluth	April 17	April 22	April 12	
Escanaba			April 4	POLARIS and AMOCO, WISC.
Marquette	April 12	April 20	April 27	
Whitefish Bay and St. Marys River	April 11	April 18	April 7	
Straits of Mackinac	April 3	April 15	March 28	S. T. CRAPO J. A. W. INGLEHART
Green Bay	April 5	April 18	April 17	
Alpena			March 19	S. T. CRAPO
Saginaw Bay			April 15	
Southern Lake Huron	March 22	March 29	March 18	MEAFORD
Western Lake Erie	March 20	March 28		
Detroit			March 21	S. T. CRAPO
Approach to Buffalo	April 8	April 14	April 9	

vessel, ASIA MORAL (10,439 tons), arrived at Montreal with an ice-damaged propeller. On April 2, the 18,586-ton Norwegian MILBANK and the Dutch SCHOUWEN arrived at Sydney, Nova Scotia, with ice damage. The 20,253-ton Liberian J. LOUIS and the 8,991-ton Norwegian ANINA sustained shell damage due to ice in the Gulf of St. Lawrence. A different type of damage was reported by the 19,210-ton British motor vessel STAR ACADIA. She suffered severe frosting of pipes, in the St. Lawrence, out of Montreal, on January 21, 1972. The Canadian laker OTTERCLIFFE HALL was trapped in pack ice in the Beauharnois Canal, on December 20.

On the Great Lakes, the 8,708-ton HENRY FORD II, bound for Detroit on January 17, was stuck in 2 ft of ice in the Livingston Channel. The 887-ton Canadian hydrographic ship NICOLET suffered shell plate damage by ice in northern Lake Michigan on April 13.

GREAT LAKES VESSEL OBSERVATION PROGRAM, 1972

This calendar year 32 vessels participated in the Great Lakes weather reporting program. A total of 12,531 observations were relayed by the participating ships. This was a decrease of 408 observations from 1971. As usual, no observations were taken or relayed from the St. Lawrence Seaway and only four were received from Lake Ontario, from two ships. The following number of observations were reported from other Lakes: Lake Erie, 601 by 29 ships; Lake Huron, 2,820 by 32 ships; Lake Michigan, 2,829 by 28 ships; Lake Superior, 6,277 by 32 ships.

During 1972, gale-force or greater winds (34 kt or greater) were reported on 90 days in the Great Lakes. There were 10 days with gales (34-40 kt) on Lake Erie, 28 on Lake Huron, 36 on Lake Michigan, and 62

on Lake Superior. Strong gales (41-47 kt) occurred 2 days on Lake Erie, 8 days on Lake Huron, 8 days on Lake Michigan,and 20 days on Lake Superior. Storm winds (48-55 kt) were logged 3 days on Lake Huron, 4 days on Lake Michigan, and 8 days on Lake Superior. Lake Huron had one report of violent storm winds (56-63 kt) as did Lake Superior. January had the most days when gales or better were reported, followed closely by December. But there were more observations of gale-force or greater winds logged during October than any other month. January and December tied for second place. Table 2 shows the number of high-wind observations for 1972 by 10 kt wind speed categories.

Table 2--Number of high-wind observations during the calendar year 1972.

High-wind categories	Observations
Wind over 30 kt	553
Wind over 40 kt	74
Wind over 50 kt	7
Wind over 60 kt	0

A total of 78 observations were made of seas over 12 ft. There were 47 observations of waves 12 to 15 ft, 25 of 15 to 20 ft, and 6 of 21 to 25 ft. More high waves were reported in December than any other month, followed by October, January, and November, in that order. The highest seas reported were 24 ft, by the ENDERS M. VOORHEES on September 6 on Lake Michigan.

Seas over 12 ft occurred on 6 days on Lake Huron, 11 days on Lake Michigan, and 27 days on Lake Superior. For all the Great Lakes, there were 32 days when one or more of the Lakes had seas over 12 ft.

Tables 3 to 9 give summaries of the maximum winds for each Lake by month, the highest wind by month on any Lake, the highest 1-min wind by Lake for each year since 1941, and the highest seas reported on each lake this year. The tables include only those observations that were logged and forwarded on the Great Lakes Weather Observation Form 72-2.

NOTABLE WEATHER HAPPENINGS, 1972

INTRODUCTION

January was the stormiest month of the year for shipping on the Lakes. There were 24 days when winds of over 30 kt were reported. The 110 observations of winds greater than 30 kt was not as many as the 134 for October, but only about one-third the total number of observations were received in January compared to October. Second place goes to December followed closely by October and then November. Rough seas were not in the same order. The roughest seas were in December, followed by October and January. Lake Superior would have to be considered as having the roughest seas.

A total of 392 gale warnings and 37 storm warnings were issued for the year. Lake Michigan, in January, had more warnings (20) than any other Lake for any month. Lake Superior was not far behind with 17. October and November on both Lake Michigan and Lake Superior were next in order of numbers of warnings.

Shipping on the Great Lakes did not have to worry about low Lake levels restricting a vessel's draft and the resulting loss of cargo capacity. In a complete reversal of the 1964 season, when it was estimated that 9.4 million tons of cargo was lost due to record low levels on Lakes Michigan and Huron, 1972-73 has been breaking records for high levels on Lakes Erie and St. Clair since September.

The levels of all the Great Lakes will be higher in 1973 than they were in 1972, except Lake Superior. Most of the Lakes will also peak earlier than normal, but lower than originally expected. The reason is that unusually mild weather in January 1973 caused early runoff of precipitation received over the basin in November and December 1972.

As in 1952, when record high levels caused considerable erosion and flooding, the current situation is critical for many activities along the Lake shores. The areas that were and will continue to be the most critical are the shores bordering Lake Erie, Saginaw Bay on Lake Huron, Lake Ontario, and southern Lake Michigan.

The following paragraphs describe some of the more severe storms that affected the Great Lakes during 1972. February and March are not included because of the lack of shipping on the Lakes. Tracks of the more intense storms are shown in figure 18. All times are GMT.

JANUARY

Six LOW centers passed over the Lakes this month. Three of these storms resulted in wind observations of greater than 40 kt. The strongest wind of the month and of the year, which was 60 kt, occurred on the 13th, on Lake Superior.

This storm tracked out of the Gulf of Alaska, across South Dakota, and the 984-mb center passed west of Sault Ste. Marie about 0400 on the 13th. At 0000 on the 13th, the CASON J. CALLAWAY, south of Isle Royale, battled these north-northeasterly 60-kt winds and 18-ft seas. Heavy continuous snow reduced the visibility to 1 mi. Along with this, the temperature was -12°C. This converts to a wind-chill temperature of below -40°C. The exact wind-chill temperature could not be readily determined as the chart does not indicate speeds greater than 45 m.p.h. On the 12th, the LEON FRASER, on Lake Michigan, was buffeted by 46-kt south-southeasterly winds and 14-ft seas. There were many reports of gale-force winds on both Lake Michigan and Lake Superior, between the 12th and 14th. The LOW moved to James Bay by 1200 on the 13th, and 24 hr later was over Ungava Bay.

A second storm this month that caused concern to Lakes ships moved across southern Canada and was over James Bay, at 1200 on the 17th. A large HIGH was over South Carolina with a tight pressure gradient between the two systems. At 1800 on the 16th, the ARTHUR M. ANDERSON, in central Lake Michigan, had to contend with 50-kt winds from the southwest and fog which reduced visibility to 200 yd. At the same time, the LEON FRASER, near Sand Island in Lake Superior, was chilled by 46-kt gales at -13°C. Six hours later the CASON J. CALLAWAY, near Chicago, was lashed by 48-kt winds. The storm sped off to the northeast and disappeared within 12 hr.

APRIL

Five cyclones moved over or near the Great Lakes that could have affected their weather, particularly wind and seas. Of these, two resulted in observations

Table 3--Maximum wind speed reported on Lake Erie for each month by National Weather Service cooperating vessels
(1972)

Month	Kt	Dir.	Time (GMT)	Date	Ship	Lat. (°N)	Long. (°W)
January				(No observations received)			
February				(No observations received)			
March				(No observations received)			
April	26	60°	1800	21	JOHN M. ANDERSON	41.9	82.8
		60°	0000	22	JOHN M. ANDERSON	42.0	81.0
		240°	1800	22	JOHN M. ANDERSON	41.8	81.7
May	26	40°	1800	7	JOHN SHERWIN	41.6	82.6
June	26	300°	0000	22	A. H. FERBERT	41.8	81.5
July	35	210°	1200	15	JOHN SHERWIN	41.9	81.8
August	42	240°	0200	3	LEON FALK, JR.	42.3	80.8
September	37	210°	0000	17	LEON FRASER	41.9	82.6
October	45	260°	1800	14	CHARLES M. BEEGHLY	42.2	81.0
November	40	220°	0600	27	WILLIAM P. SNYDER, JR.	41.8	82.4
December	40	300°	0000	17	G. M. HUMPHREY	41.9	83.0
Year	45	260°	1800	October 14	CHARLES M. BEEGHLY	42.2	81.0

Table 4--Maximum wind speed reported on Lake Huron for each month by National Weather Service cooperating vessels
(1972)

Month	Kt	Dir.	Time (GMT)	Date	Ship	Lat. (°N)	Long. (°W)
January	45	70°	0900	26	EDISTO	45.8	84.5
February				(No observations received)			
March	19	220°	0000	31	MACKINAW	45.5	84.1
April	35	110°	1200	22	LEON FRASER	44.7	82.8
May	34	320°	0000	7	ERNEST R. BREECH	44.8	83.0
June	48	350°	0000	23	A. H. FERBERT	43.6	82.4
July	28	250°	0000	13	EDMUND FITZGERALD	43.7	82.8
August	32	310°	1200	3	ERNEST R. BREECH	45.3	83.4
September	38	210°	0600	17	RESERVE	44.4	83.0
October	56	320°	0000	17	JOHN DYKSTRA	45.4	83.4
November	42	240°	0600	24	ERNEST T. WEIR	44.2	82.9
December	48	240°	0600	13	PAUL CARNAHAN	44.3	82.8
Year	56	320°	0000	October 17	JOHN DYKSTRA	45.4	83.4

Table 5-- Maximum wind speed reported on Lake Michigan for each month by National Weather Service cooperating vessels
(1972)

Month	Kt	Dir.	Time (GMT)	Date	Ship	Lat. (°N.)	Long. (°W.)
January	50	220°	1800	16	ARTHUR M. ANDERSON	44.1	87.4
February	40	290°	0600	4	ENDERS M. VOORHEES	42.0	87.4
March	23	220°	1800	31	EDISTO	45.9	85.6
April	40	110°	0600	13	ARTHUR M. ANDERSON	45.7	86.0
May	38	10°	1800	30	FRANK ARMSTRONG	41.9	87.4
June	36	360°	0000	23	ARTHUR M. ANDERSON	42.7	87.0
July	54	350°	0600	2	PAUL H. CARNAHAN	43.0	87.5
August	34	340°	0000	9	ENDERS M. VOORHEES	44.2	86.6
September	40	200°	0000	17	PHILLIP R. CLARKE	45.0	85.9
October	42	240°	0600	16	LEON FRASER	45.8	84.9
November	40	310°	0600	8	JOHN SHERWIN	42.7	87.6
December	45	300°	1800	6	ENDERS M. VOORHEES	43.6	87.5
Year	54	350°	0600	July 2	PAUL H. CARNAHAN	43.0	87.5

Table 6--Maximum wind speed reported on Lake Superior for each month by National Weather Service cooperating vessels (1972)

Month	Kt	Dir.	Time (GMT)	Date	Ship	Lat. (°N)	Long. (°W)
January	60	30°	0000	13	CASON J. CALLAWAY	47.7	89.9
February				(No observations reported)			
March				(No observations reported)			
April	36	30°	0600	24	BENJAMIN F. FAIRLESS	47.5	85.5
May	40	340°	1800	6	EDMUND FITZGERALD	47.3	86.3
		330°	1800	6	ARTHUR M. ANDERSON	47.2	86.3
June	42	10°	1800	20	RESERVE	47.7	87.0
July	30	160°	1200	14	IRVING S. OLDS	47.3	87.0
August	33	40°	0600	22	PHILLIP R. CLARKE	47.3	89.5
September	52	180°	0000	7	JOHN DYKSTRA	46.7	86.5
October	52	260°	1800	16	LEON FALK, JR.	47.5	87.6
November	48	270°	1200	23	JOHN SHERWIN	47.2	87.6
December	52	220°	1800	17	LEON FALK, JR.	47.2	90.0
Year	60	30°	0000	January 13	CASON J. CALLAWAY	47.7	89.9

Table 7--Maximum wind speed reported for each month for the entire Great Lakes (excluding Lake Ontario) by National Weather Service cooperating vessels (1972)

Month	Kt	Dir.	Time(GMT)	Date	Lake	Ship	Lat. (°N)	Long. (°W)
January	60	30°	0000	13	Superior	CASON J. CALLAWAY	47.7	89.9
February	40	290°	0600	4	Michigan	ENDERS M. VOORHEES	42.0	87.4
March	23	220°	1800	31	Michigan	EDISTO	45.9	85.6
April	40	110°	0600	13	Michigan	ARTHUR M. ANDERSON	45.7	86.0
May	40	340°	1800	6	Superior	EDMUND FITZGERALD	47.3	86.3
		330°	1800	6	Superior	ARTHUR M. ANDERSON	47.2	86.3
June	48	350°	0000	23	Huron	A. H. FERBERT	43.6	82.4
July	54	350°	0600	2	Michigan	PAUL H. CARNAHAN	43.0	87.5
August	42	240°	0200	3	Erie	LEON FALK, JR.	42.3	80.8
September	52	180°	0000	7	Superior	JOHN DYKSTRA	46.7	86.5
October	56	320°	0000	17	Huron	JOHN DYKSTRA	45.4	83.4
November	48	270°	1200	23	Superior	JOHN SHERWIN	47.2	87.6
December	52	220°	1800	17	Superior	LEON FALK, JR.	47.2	90.0
Year	60	30°	0000	January 13	Superior	CASON J. CALLAWAY	47.7	89.9

of winds greater than 30 kt.

On the 12th, a HIGH was centered over James Bay, and a LOW was centered over the Wyoming-South Dakota border. The LOW moved eastward and, at 1200 on the 13th, was over western Wisconsin. Rain, thunderstorms, and snow in the northern areas accompanied the storm. At 0000 on the 13th, the ARTHUR M. ANDERSON, heading north in Lake Michigan, was receiving 33-kt easterly winds. Six hours later, she was pelted by a thunderstorm with 40-kt gales. The LEON FRASER and CASON J. CALLAWAY in the same general area had 35-kt gales. Three tornado funnels touched down in the State of Michigan causing considerable property damage. On the 1200 chart, a new LOW had developed and passed over Lake St. Clair and moved across Lake Ontario.

Another storm caused problems on Lake Huron and Lake Superior. On the 21st, a LOW was centered in Missouri and moved northeastward and was over Sheboygan, Wis., at 1200 on the 22d. At 1200 the next day, it was centered over the Mackinac Straits. A weakening occluded front extended southeastward from the center. The LEON FRASER on Lake Huron received 35-kt winds and 12-ft seas. Visibility was restricted with drizzle falling. The high winds and waves caused ice to pile up on the windward shores.

Table 8.-- Highest 1-min wind (kt) reported on the Great Lakes by U.S. anemometer-equipped vessels

Year	Lake Erie		Lake Huron		Lake Michigan		Lake Superior		Lake Ontario	
1941	W	42	WSW	50	NW	43	NNW	54	--	--
1942	WSW	52	WSW	56	WNW	48	S	62	--	--
1943	WSW	57	WNW	43	SSW	50	WSW	52	--	--
1944	NE	38	NW	37	WSW	48	NNE	42	--	--
1945	WNW	52	SSW	54	WNW	49	NW	52	--	--
1946	SW	50	W	46	S	44	NW	47	--	--
1947	NW	51	SSE	43	ENE	39	WSW	43	--	--
1948	WSW	40	NNW	51	NW	45	WSW	48	--	--
1949	W	52	NNE	50	NNW	43	N	52	--	--
1950	SW	70	NW	48	NW	49	NW	81[1]	--	--
1951	WSW	37	WSW	50	SW	49	WSW	54	--	--
1952	SW	46	SW	57	SSW	44	WSW	45	--	--
1953	WSW	49	NW	45	NNW	46	ENE	50	--	--
1954	W	45	NW	45	E	48	N	43	--	--
1955	W	52	SW	57	WSW	58[1]	NW	48	--	--
1956	WSW	46	W	43	SSW	46	N	50	--	--
1957	WSW	72	SW	54	WSW	49	W	47	--	--
1958	SW	61	SW	43	SW	52	SSW	54	--	--
1959	W	42	NE	50	E	48	W	54	--	--
1960	NE	55	WSW	49	NW	55	N	54	--	--
1961	W	50	NW	47	NW	48	N	57	--	--
1962	NW	52	WNW	63	NW	48	NNW	60	--	--
1963	NNW	74[1]	NW	60	N	52	NNW	52	E	35
1964	WSW	68	W	72	NW	54	WSW	62	WNW	50[1]
1965	WSW	60	WNW	95[1]	ESE	52	SW	70	W	40
1966	ENE	49	NE	60	NW	57	NNE	61	W	39
1967	WSW	43	W	58	ENE	55	N	53	W	32
1968	W	63	NNW	44	WNW	46	NNE	55	SW	31
1969	WSW	44	NNW	46	NW	50	SSW	50	--	--
1970	W	52	W	62	NW	52	W	63	--	--
1971	SW	50	N	53	N	50	SW	56	--	--
1972	W	45	NW	56	N	54	NNE	60	--	--

[1] Highest for each lake

MAY

May got off to a bad start as far as winds on the Lakes are concerned, and ended the same way. A LOW moved across Iowa on the 2d, and was over Manitoulin Island at midday on the 3d. The ARTHUR M. ANDERSON, on Lake Superior, caught 32-kt northeasterly winds, late on the 1st. Six hours later, at 0000 on the 2d, the winds shifted to the southwest at 33 kt as she sailed westward. The ERNEST R. BREECH found 38-kt gales in the same area. Eighteen hours later, the EDMUND FITZGERALD was treated to 34-kt northeasterly gales with rain.

The storm that caused the highest winds on the Lakes this month originated in Minnesota late on the 5th. At noon the next day it was well developed and centered over Lake Superior. By 1200 on the 7th, it had raced to the Gulf of St. Lawrence. Two ships, very near each other--the EDMUND FITZGERALD and the ARTHUR M. ANDERSON--had 40-kt northwesterly winds. The temperature was near freezing and snow showers were in the area. The strong wind moved eastward with the storm and, at 0000 on the 7th, the ERNEST R. BREECH reported 34-kt gales from 320°. A HIGH moved across Lake Superior following the LOW and, on the 8th and 9th, northeasterly winds caused flooding along the Ohio shore of Lake Erie.

This LOW was born on the 29th and passed over Lakes Michigan and Huron on the 30th. At 1800 on the 30th, the FRANK ARMSTRONG, on Lake Michigan, experienced 38-kt northerly winds and the JOHN SHERWIN on Lake Huron had 31 kt.

JUNE

June was a very quiet month until hurricane Agnes, late in the month. A complete rundown on Agnes is contained in the article "North Atlantic Tropical Cyclones, 1972" appearing in the January 1973 issue of the Mariners Weather Log.

Agnes started as a depression on the 15th, off the Yucatan coast. She moved ashore near Panama City, Fla., on the 19th. After moving offshore near Norfolk, Va., on the 22d, she moved ashore again over New York City and wandered over Pennsylvania, New York, and Ontario, until the 26th. At that time, extratropical Agnes moved east to Nova Scotia and open

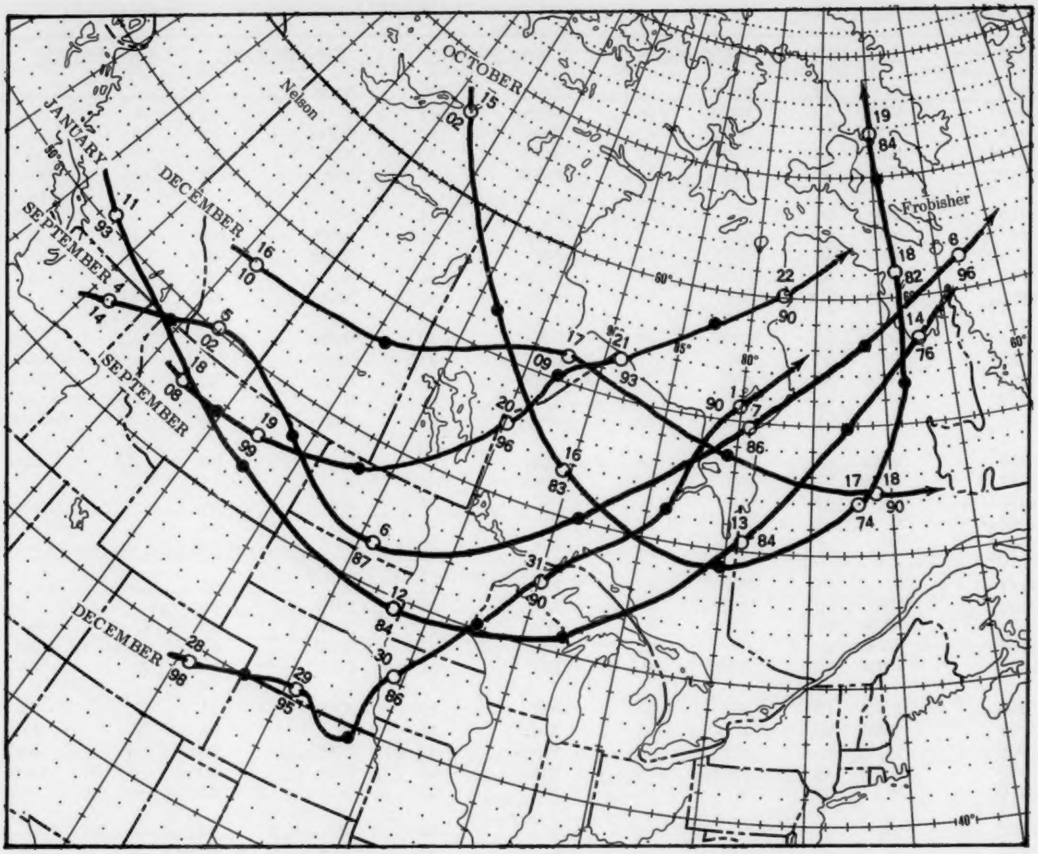


Figure 18.--Tracks of Great Lakes storms containing winds greater than 50 kt or open-water seas greater than 20 ft. Open circle indicates position of center at 1200 of date shown, and closed circle indicates 0000 position. Figure below open circle indicates pressure to nearest millibar.

water.

Lakes shipping began to feel the effects of Agnes on the 22d. The 22d and 23d were the worst days as Agnes moved against a 1032-mb HIGH over James Bay resulting in a tight pressure gradient. By the 24th, the HIGH had moved northeastward and Agnes was filling, relaxing the gradient considerably.

The highest wind reported by a Lakes ship was 48 kt from the north on Lake Huron, near 43.6°N, 82.4°W, by the A. H. FERBERT. At that time, 0000 on the 23d, the seas were 9 ft. At 1200 on the 22d, the JOHN SHERWIN near 43.7°N, 82.5°W (Lake Huron) and the EDMUND FITZGERALD near 44.1°N, 82.6°W (Lake Huron), were buffeted by 44- and 41-kt gales, respectively. Winds over 30 kt were measured on both Lake Michigan and Lake Superior.

Along the Michigan shore of Lake Huron, the prolonged northerly winds produced 12- to 15-ft waves and extensive erosion along the shoreline. Seawalls were destroyed and many homes damaged. The south shore of Lake Erie was hard hit by waves over 15 ft caused by northeasterly winds. The already high lake level rose 3.5 ft above normal at the southern shore. Houses, cars, boats, buildings, ships, and docks were victims of the wind-driven waves. Damage was estimated at $4 million.

JULY

The major cyclone tracks have moved to the north, across central Canada by this time of the year. Most of the high winds and seas, therefore, are associated with frontal activity and violent thunderstorms, either individually or with squall lines. This was the case on July 2, at 0600, when the PAUL H. CARNAHAN on lower Lake Michigan encountered 54-kt storm winds from the north. A weak cold front, oriented northeast-southwest, extended across Lake Michigan. Thunderstorms were occurring throughout the area, and the CARNAHAN reported squalls within sight during the past hour. Thirty hours later, the JOHN SHERWIN, also near Chicago, reported rain in sight with 31-kt northerly winds.

The second period in the month when high winds were recorded by Lake ships was the 14th and 15th--this time on Lake Erie. A LOW tracked across Canada, north of the Lakes, on these 2 days. A

Table 9--Highest seas reported on the Great Lakes (excluding Lake Ontario) by National Weather Service cooperating vessels (1972)

Lake Erie:	JOHN SHERWIN on July 15, and CHARLES M. BEEGHLY on October 14--seas 9 ft
Lake Huron:	ARTHUR M. ANDERSON on December 16--seas 15 ft
Lake Michigan:	ENDERS M. VOORHEES on September 6--seas 24 ft
Lake Superior:	ENDERS M. VOORHEES on December 31--23 ft

warm front extended southeastward across Lake Erie, on the 14th. The JOHN SHERWIN, which was now north of Sandusky, was within sight of squalls when the wind picked up to 32 kt out of the southwest. Thirty-six hours later, the SHERWIN reported thunder with 36-kt winds. The waves this time were 9 ft. The cold front associated with the LOW lay across Lake Huron with a squall line ahead of it over Lake Erie.

Although there were no ship reports from the other Lakes, high winds must have occurred, as thunderstorms were reported in Illinois, Wisconsin, Michigan, and Ohio. Tornado activity also was prevalent in Illinois and Wisconsin along the Lake Michigan shore. Lightning, hail, and winds resulted in considerable damage to the north Chicago area.

AUGUST

Lake Erie took the award this month for the highest wind, and in almost the same circumstance as on Lake Michigan last month. At 0000 on the 3d, a cold front was east of Chicago and a warm front lay over Lake Ontario. The LEON FALK, JR., near Cleveland, was hit by a violent shower and 42-kt gales from the west-southwest according to a 0200 special observation. The visibility was only 50 yd at the time. Ten hours later on Lake Huron, the ERNEST R. BREECH had 32-kt winds from the northwest with no indication of a storm in the area.

Early on the 9th, a LOW moved eastward over Lake Huron, and at 1530 that day, a waterspout was observed over the Lake, off the entrance to Saginaw Bay. The ENDERS M. VOORHEES, off Manitowac, Wis., at 0000, found 34-kt winds from the north-northwest.

On the 22d, two waves were rippling along a front across the Lakes area. One was centered over Sault Ste. Marie, and another was near Madison, Wis. Three ships on Lake Superior were treated to 31- to 33-kt gales. They were the PHILLIP R. CLARKE, WILLIAM A. IRVIN, and the CHARLES M. SCHWAB.

SEPTEMBER

The strongest wind recorded on the Great Lakes for this month was over Lake Superior, on the 7th. A LOW tracked across North Dakota and upper Minnesota and, at 0000 on the 7th, was centered north of Port Arthur, Ontario. At that time, the JOHN DYKSTRA, north of Grand Island, was hit by southerly winds of 52 kt maximum speed. The PHILLIP R. CLARKE, about 60 mi to the northwest, enjoyed 33-kt breezes. The ERNEST R. BREECH, near Duluth, reported 32-kt winds with squalls in the area. Six hours earlier, 1800 on the 6th, the ENDERS M. VOORHEES reported the highest seas for the year--24 ft--near the center of Lake Michigan. At the time the wind was reading 27 kt from the south. The LOW continued its march northeastward and at 1200 was over James Bay. At 0600, the LEON FRASER, near the east end of Lake Superior, had 33-kt winds and reported lightning visible. At the same time, the RESERVE, close by, contended with 38-kt gales.

Lake Superior was the favorite lake for winds this month. On the 20th, a LOW was near Lake Winnipeg and on the 22d moved into Hudson Bay. At 1200 on the 20th, the second highest wind for the month (44 kt) was reported by the ARMCO, in the western part of Lake Superior. Many other ships reported winds of 30 to 40 kt on both Lake Superior and Lake Huron for the next 48 hr as the LOW moved northeastward. Among those to deserve honorable mention is CHARLES M. BEEGHLY. Sailing westward on Lake Superior, she encountered 21-ft seas running from the west-northwest with 35-kt gales. The north shore of Lake Superior received 3 to 5 in. of rain in a 10-hr period, causing flooding in Duluth and other shore communities. In Wisconsin, tornadoes were reported over many counties.

Another period of stormy weather on Lake Superior was the 28th. At 1200 that day, a frontal system was approaching from the west. In the southeasterly flow ahead of the front, the JOHN DYKSTRA and the CASON J. CALLAWAY reported 43- and 40-kt winds.

OCTOBER

More reports of winds over 30 kt were received from lakers this month than any other month during the year. A LOW moved out of north-central Canada, on the 15th and 16th. At 0000 on the 17th, the 977-mb center was located at the southern tip of James Bay. A cold front extended southwestward across Lakes Huron and Michigan. The JOHN DYKSTRA, just west of the front, on Lake Huron, was whipped by 56-kt northwesterly winds and cold rain. On Lake Superior, the ARTHUR M. ANDERSON was embraced by 40-kt freezing gales and 21-ft seas--the highest for the month. Six hours earlier, the LEON FALK, JR. on Lake Superior was also raked with 52-kt westerlies. The JOHN SHERWIN on Lake Huron found the same 52-kt winds, at 0000 on the 17th. At 1800 on the 16th, seven other ships reported winds of 40-kt or greater, and, at 0000 on the 17th, five other vessels reported winds that high. Winds in the 30-kt category were reported on Lake Michigan. The weather quieted down as the LOW moved to the east then northeast toward the Labrador Sea. Near Charlevoix on Lake Michigan, a barge broke loose from its tug and beached. Power outages were reported in many Upper Peninsula Michigan communities due to wind and toppled trees. Campers were escorted across the Mackinaw Bridge. On the Lake Superior shore, near Eagle River, severe damage was caused by waves. Two men were assumed lost on wind-swept Whitefish Bay as peak gusts reached 65 kt in that area.

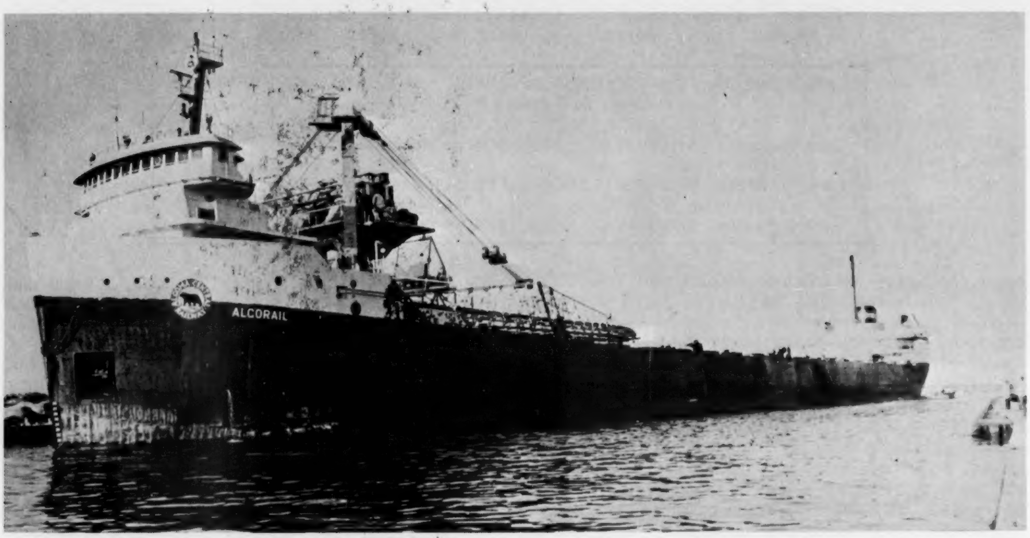


Figure 19.--High winds blew the ALGORAIL against a pier in Holland, Mich., and damaged the vessel's bow. The 14-ft gash is plainly visible just above the waterline. Photo courtesy of Grand Haven Tribune.

Several other storms passed near the Lakes this month, notably on the 8th-9th and 26th-27th. These storms caused only isolated wind reports in the 30-kt category. The ALGORAIL was damaged when strong winds blew the vessel against a pier, tearing a 12- to 14-ft gash above the waterline near her bow (fig. 19). The incident occurred in the Holland, Mich., Harbor Channel on October 6.

NOVEMBER

A LOW that came out of the northern Plain States was centered over Chicago, at 1200 on the 7th. By this time, the circulation had started to consolidate and the wind speeds were increasing. Between this time and 1200 on the 8th, when the center was over Niagara Falls, several ships reported high winds. The IRVING S. OLDS reported 36-kt north-northeasterly winds and the J. L. MAUTHE recorded 41-kt northerly winds both on Lake Superior, on their observations for 1800 on the 7th. Six hours later, as the J. L. MAUTHE cruised eastward, the wind increased to 44 kt, the second highest speed recorded on the Lakes for this month. Seas were 12 ft at that time. Winds over 30 kt were measured by the JOHN SHERWIN on Lake Michigan and the PAUL H. CARNAHAN on Lake Huron, during the next 18 hr.

The second storm of the month came out of the Oklahoma-Kansas border area, on the 13th. The LOW center tracked up the Ohio River valley on the 14th, producing northeasterly winds over the Great Lakes. Winds of 20 to 30 kt with gusts over 40 kt were recorded over parts of Illinois, Michigan, and Ohio. Port Clinton, Ohio, had winds clocked at 65 kt with gusts to 95 kt. Ashtabula, Ohio, reported winds of 50 kt and gusts to 61 kt. Toledo reported 12-ft waves. Waves of 6 to 12 ft occurred all along the south and west shore of Lake Erie. What was described as huge waves, whipped up on Lake Michigan (fig. 20), damaged seawalls and flooded roads and shore homes. A youth was swept off a breakwater and drowned. The high waves and water ride-up on top of the record high Lake levels resulted in extensive flooding. In Michigan, an estimated 8,000 persons were evacuated from their homes due to flooding. Damage was estimated at $7.5 million. In Ohio, flood and wind damage was estimated at $22 million and over 3,000 families were effected by the storm. No deaths were reported in Ohio or Michigan due to the storm, but the storm was, at least partially, responsible for 19 deaths in its sweep across the United States to the Atlantic. Tornadoes were triggered in Texas, heavy rains in the northeast, and up to 18 in. of snow in Vermont and Maine. Flash floods occurred in many areas. A more complete description of this storm appears in the article "Fall Storm and High Lake Levels Spell Disaster Around the Great Lakes," in the March, 1973 issue of the Mariners Weather Log.

The winds and waves reported by ships during this storm were not as high as would be expected, considering the wind speeds reported by shore stations. The strongest was 39 kt encountered by the CHARLES M. BEEGHLY and the PAUL H. CARNAHAN on Lake Huron, early on the 14th. On the western end of Lake Erie, the CASON J. CALLAWAY was the winner with 38 kt. The MIDDLETOWN, on Lake Huron, was tossed by 11-ft waves driven by 38-kt gales. By the 15th, the storm had moved far enough east that ship-reported winds had decreased to below 30 kt.

The highest wind for the month, reported on a synoptic observation, occurred late in the month on the 23d. A LOW had moved across Hudson Bay and, at 1200 on the 23d, was in northern Quebec. A HIGH was centered north of the Gulf Coast and basically zonal flow stretched across the northern United States and southern Canada. The JOHN SHERWIN, near the middle of Lake Superior, was headed toward the Soo Locks, when the westerly winds increased to 48 kt from 32 kt, 6 hr before. The ERNEST T. WEIR, at

0600 on the 24th on Lake Huron, contended with west-southwesterlies of 42 kt. The laker with the highest waves was the ARTHUR M. ANDERSON, at 0000 on the 24th, with 18-ft seas and 34-kt gales, out of Duluth on Lake Superior. The winds dropped rapidly as a cold HIGH followed the LOW across Canada and the Lakes were sandwiched between two HIGHS, breaking up the zonal flow pattern.

DECEMBER

December was a close second in the number of wind reports over 30 kt received from ships on the Great Lakes. A storm that contributed its share of these was over Green Bay, Wis., at 0000 on the 6th. At 1200 on the 7th, 36 hr later, it had raced to Cape Chidley. The gale winds all occurred on the back side of the LOW after it passed over the Lakes. The strongest wind was 45 kt, on Lake Huron at 0000 on the 7th, measured by the G. M. HUMPHREY. The -11°C temperature made it even more uncomfortable. The ENDERS M. VOOHREES, on Lake Michigan also reported 45 kt from the northwest with 1 mi visibility due to ice fog. The storm played no favorites as all Lakes received their share of wind. The ARTHUR M. ANDERSON, on Lake Superior, sailed cautiously with 38-kt winds, 18-ft seas, and 50-yd visibility due to fog depositing rime. The PAUL H. CARNAHAN had it easier, on Lake Erie, with the same wind speed but only 5-ft seas and no fog.

On the 16th, a large HIGH covered the midwestern Plain States with two centers. Early in the 17th, they combined into one center in Iowa and moved southeastward. A LOW was moving across the top of the HIGH in southern Canada with a tight pressure gradient between the two systems. On the 18th, they squeezed the Lakes between them as the LOW passed to the north and the HIGH to the south. A cold front lay east-west across the Lakes. At 1800 on the 17th, the LEON FALK, JR. about 100 mi out of Duluth and south of the front took southwesterly winds of 52 kt. Earlier, the ARTHUR M. ANDERSON, further east and north, on the cold side of the front had 38-kt northwesterly gales and 18-ft seas. The ASHLAND on central Lake Superior reported 37-kt gales. Lakes Erie, Huron, and Michigan all received winds of 40 kt or greater.

The last LOW of the year came out of the midwest, moving north-northeastward across Iowa and Wisconsin to western Lake Superior, at 1200 on the 31st. There were two reports of 50-kt winds, both from the northeast and from Lake Superior. The first was from the ENDERS M. VOORHEES at 1800 on the 30th, and the second was from the LEON FRASER at 0000 on the 31st. Both ships also reported very high seas for the Lakes. The VOORHEES made two reports of 23-ft waves near the western end of the Lake, at 0000 and 0600 on the 31st. The FRASER, nearer Duluth, and 6 hr earlier, rode out 46-kt northeasterly winds with 20-ft seas on her bow. This storm was oriented such that the higher winds and seas occurred mainly over Lake Superior. This was due to the direction of the wind and the orientation of the Lakes. Flooding from rain and melting snow caused problems in southern Michigan and in Illinois counties bordering Lake Michigan. Blizzard conditions covered northeastern Minnesota where all land and air traffic virtually came to a standstill.

Figure 20.--Parking ticket? Cabin cruiser winds up atop seawall in Chicago small-boat harbor during storm of November 14. Normally, water level is 3 ft below the seawall, but high Lake levels and storm-whipped waves placed the cruiser in line for a parking violation. Wide World Photos.

ACKNOWLEDGMENTS

I wish to express my thanks to the many masters and mates aboard the cooperating Great Lakes vessels for their valuable observations and contributions to the National Weather Service observing program. The climatologists for the bordering States were very helpful with their storm damage reports and data sent to me personally. I would also like to recognize the useful information and pictures obtained from the Great Lakes News Letter. Of primary importance, I must acknowledge the data supplied by the Environmental Data Service, National Climatic Center, Asheville, N.C., on wind and waves on which much of the article is based. In addition, our thanks go to the National Weather Service Forecast Offices in Detroit and Cleveland and to the Coast Guard Ice Navigation Center for a description of the environmental services furnished mariners.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US, THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

Hints to the Observer

RADAR REPORTING OF TROPICAL CYCLONES

The appearance of a hurricane or typhoon on marine radar depends on the characteristics of the radar, especially the maximum range, and on the location of the radar with respect to the storm center. Short-range radars are rarely near enough to view the center of the storm and may view such a small portion of the storm that identification is difficult. On longer range radars, heavy rainfall may so attenuate the signal that rainfall at the outer edges of the scope is not detected. Figures 21, 22, 23, and 24 contain examples of hurricanes and typhoons as seen by radar.

Weather echoes from near the perimeter of tropical cyclones are not always recognizable, especially on a radar with limited range. The curve of the spiral bands is flat near the perimeter and gets sharper near the center. A precursor line, which usually has unrecognizable curvature, may be the first indicator of the approach of a hurricane or typhoon, sometimes running 200 mi ahead of the storm center. This line has heavy rains and squalls. The first spiral band of the storm may be as much as 50 mi behind the precursor line. An area of steady rain may be as much as 100 mi wide in advance of the center, but is usually less in the direction opposite the storm's path. The eye of a hurricane or typhoon varies greatly in size, being usually 10 to 30 mi across. There is not always an echo-free area as seen on radar, but a center of circulation may sometimes be determined even when no eye appears. Your radar's view of weather patterns can be very informative to meteorologists. Whenever you are in or near a tropical storm, hurricane, or typhoon, remarks describing briefly the radarscope weather patterns can be added to your weather transmission. The form of the remarks is shown below. If you cannot report any particular element, simply omit it and report what you can.

Radar Remarks

1. Identification and time of radar observation
   Always precede radar reports with the word RADAR. The time ascribed to the report is that time, GMT, when the location of an eye or center, if one exists, was determined. Otherwise, it is the time the observation was completed.

2. EYE or CENTER location
   Report the location in latitude and longitude to the nearest minute. If there is a circular or oval area without echoes, about which circulation is obvious, report the EYE. If the center of circulation can be determined, but there is no eye, report the CENTER.

Figure 21.--This is a full-fledged hurricane as seen by the National Weather Service long-range radar. The range setting of the scope is 150 mi. The line of echoes running generally east-west across the upper part of the scope is a precursor line with heavy squalls.

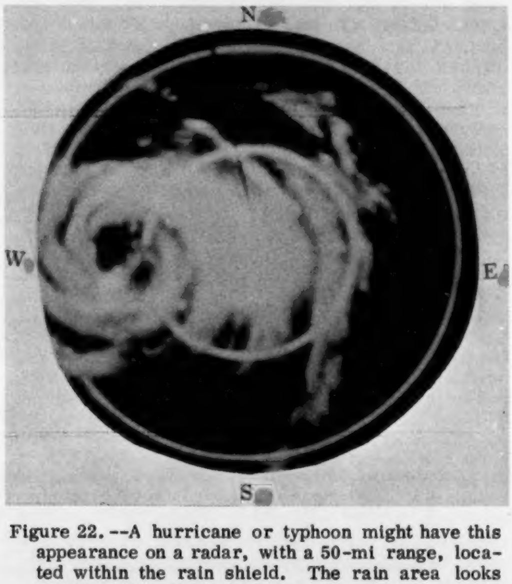


Figure 22.--A hurricane or typhoon might have this appearance on a radar, with a 50-mi range, located within the rain shield. The rain area looks smaller than its actual size because the radar signal is attenuated by the heavy rainfall. Spiral bands cover nearly all the scope, and the eye is about 12 mi in diameter, centered 32 mi west.

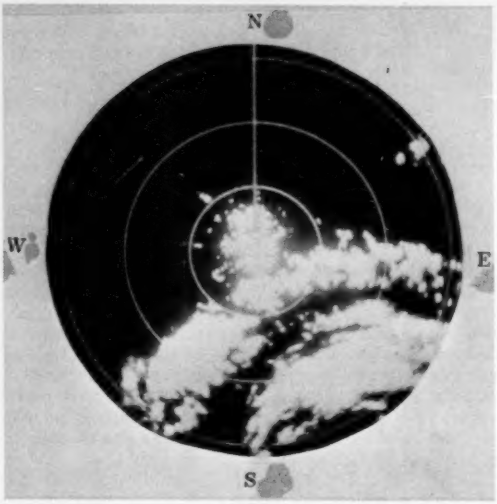


Figure 23. --This radar is very near a spiral band. The eye is not in range but is located southeast of the ship.

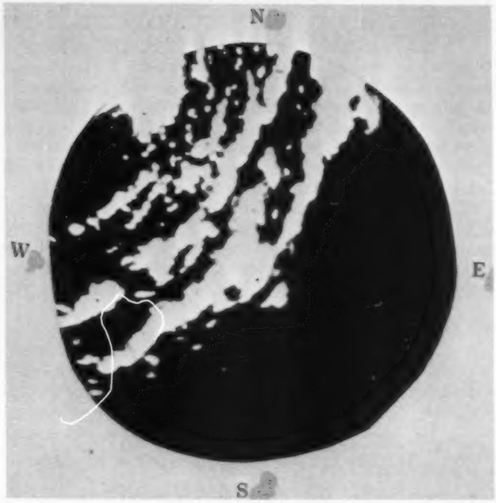


Figure 24. --Spiral bands cover half this scope, and it appears the rain shield is visible at the edge of the scope. This radar is probably not as near the storm center as the one in figure 23, because the spiral curvature is not as sharp. The eye is located is the northwest of the ship.

3. DIAMETER of eye, in nautical miles

4. Features of eye
   Examples: a) ELONGATED NORTH TO SOUTH
   b) BECOMING LARGER
   c) OPEN SOUTHWEST (Caution: due to attenuation of the signal by heavy rainfall, the side of the eye opposite the radar may appear open when it is not.)

5. Brief description of other precipitation echoes seen on radar
   Examples: a) CURVED LINE FROM WEST 20 MILES TO NORTH 25 MILES TO NORTHEAST 30 MILES
   b) SPIRAL BANDS NORTHEAST QUADRANT
   c) HEAVY RAIN WEST

Examples of Radar Remarks

A. RADAR 1540Z EYE 2248N 6012W DIAMETER 15 OPEN SOUTHWEST HEAVY RAIN ENTIRE SCOPE
B. RADAR 0950Z SPIRAL BANDS WEST AND SOUTH
C. RADAR 1145Z CENTER 1223N 14212E SPIRAL BANDS COVER SCOPE

Tips to the Radio Officer

Warren D. Hight
National Weather Service, NOAA
Silver Spring, Md.

RADIO NBA, BALBOA, C.Z., WEATHER BROADCAST CLOSED DOWN

For a 60-day trial period that began April 1, 1973, the Radio NBA Weather broadcasts are cancelled. During the trial period warnings and forecasts for the eastern North Pacific, east of 140°W and south of 30°N, which had been broadcast by Radio NBA, are being broadcast by Radio NSS, Washington, D.C. immediately following the regular weather bulletin for the western North Atlantic.

RADIO WWV, FT. COLLINS, COLO., ADDS AN ADDITIONAL 45-SEC WEATHER BROADCAST

The National Weather Service recently added a third 45-sec weather broadcast to the hourly program on Bureau of Standards Time and Frequency Station WWV, Ft. Collins, Colo. The new segment commences at 12 min past each hour and contains storm information for the eastern North Pacific east of 140°W. The other two 45-sec weather broadcasts commence at HH+08 and HH+10 and cover the western North Atlantic.

PUBLICATION WORLDWIDE MARINE WEATHER BROADCASTS

We suppose that most radio officers are expecting Worldwide Marine Weather Broadcasts to be issued soon. It looks quite certain now that the booklet will be ready for distribution to ships in the cooperative weather program about September 1, 1973. So, please bear with us for a few more months.

RADIO OFFICERS COMMENT

We recently received much useful information and constructive comment from the following radio officers:

Ben Lane, States Steamship Co.
Fred Becker
Rosales Gonzaga, NORDFELS
John Oberlin, HESS VOYAGER
William Yerger, MORMACVEGA

Hurricane Alley

Richard M. DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

Recent years have seen an increase in the number of ships traversing the tropical seas of the world. In response to this increase we feel that expanded tropical cyclone coverage will benefit the mariner. Starting in the next issue, this column will contain a monthly summary of tropical cyclones in the Indian Ocean and Southern Hemisphere. In the past, the Mariners Weather Log has covered the major storms in these Oceans, and stories were based mainly on newspaper accounts. With the increased satellite coverage and improved tropical weather analyses, these summaries will now be similar to those that appear in the Smooth Logs for the North Atlantic and North Pacific Oceans; the months will also coincide. So next issue we will begin with January and February, which is the heart of the Southern Hemisphere tropical cyclone season.

Northern Hemisphere tropical cyclone regions include the North Atlantic, Eastern and Western North Pacific, and the Indian Ocean. In the Southern Hemisphere two areas are usually delineated. The South Indian Ocean covers a stretch from the east African coast to about 100°E. The South Pacific region extends from 100°E to about 160°W, which includes Australia. Tropical cyclone regions of the world are shown in figure 25.

In addition to the routine summaries, this column will feature any tropical cyclone information that might be of interest to the mariner--from new publications to old sea tales.

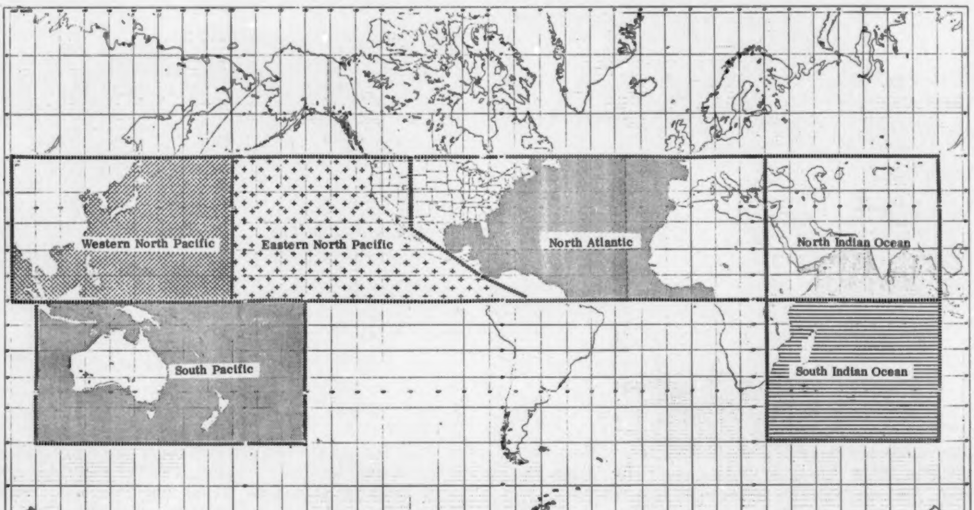


Figure 25.--World tropical cyclone regions.

On the Editor's Desk

SKYWAVE RADAR REMOTELY SENSES SEA STATE FROM SHORE BASES

Skywave radar has successfully observed sea conditions over an area extending hundreds of miles from shore-based antennas in experiments conducted by NOAA's Environmental Research Laboratories' Wave Propagation Laboratory. The skywave radar technique appears to be an ideal method for remotely sensing sea state and other oceanic conditions out to great distances from land. For example, one skywave radar site in Kentucky could observe the ocean's surface behavior along the entire Atlantic coast and some 1,200 mi out to sea, in virtual real time.

The radar-scanning technique would also help in predicting destructive wave activity along our coasts, permit routine computations of average wind conditions over the scanned areas, and provide a means of locating and tracking ships and small craft in distress anywhere within the radar's range.

The use of skywave radar to monitor distant sea state has been under development since 1967 in elements of NOAA, and has been the subject of experiments conducted from San Clemente Island, off southern California. Other organizations, including the Naval Research Laboratories and the Stanford Research Institute, have also been experimenting with this application of skywave radar.

Unlike more familiar types of radar which send out signals along a line of sight then "listen" to the echoes returned from objects along the radio signals path, skywave radar beams high frequency radio signals toward the ionosphere, which reflects the signals earthward at great distances from the radar. Echoes--or backscatter--returning to the transmitting site over the same path can be used to infer the ocean wave heights, length, and direction of travel.

COAST GUARD USES CUTTERS TO TRACK ICEBERGS

More than 100 large Arctic icebergs off Newfoundland's Grand Banks are posing a serious threat to maritime shipping in the North Atlantic and have prompted the Coast Guard to begin tracking the bergs by ship for the second consecutive year. Some have already entered shipping lanes and dropped as far south as 900 mi due east of Boston, Mass.

How long the Coast Guard will monitor the icebergs this year depends on finding out how many bergs there are along the coast of Labrador and northern Newfoundland and predicting how severe the ice season will become. Earlier reconnaissance flights showed about a dozen bergs below the 43d parallel at the southern edge of the Grand Banks region. Icebergs anywhere near the traffic lanes concern the ice patrol officials, but those bergs which fall below the 48th parallel are of particular interest.

In February of this year, there were 110 bergs below the 48th. Last year during February, 40 were found below the 48th.

The Coast Guard began its annual international ice patrol this year on January 24--more than a month earlier than normal. Since then, Coast Guard aircraft deployed to the Canadian Forces Base at Summerside, Prince Edward Island, from Elizabeth City, N.C., have made regular flights over the shipping region charting and tracking the icebergs. Information from these flights plus sightings made by ships and other aircraft are funneled into Governors Island and fed into a computer along with ocean current and weather information every 12 hr. Then, the predicted position of the bergs is transmitted twice daily from radio stations in the United States and Canada.

TOTAL SOLAR ECLIPSE-JUNE 30, 1973

A total eclipse of the sun (fig. 26) will occur June 30, 1973 and it may be possible for some mariners to observe it, if their ship happens to be in the right place at the right time.

The path of the total eclipse (fig. 27) touches the earth at sunrise on the Brazil-Guyana border and leaves South America along the Guyana-Surinam coast about 0955. Traveling in a northeasterly direction across the North Atlantic Ocean, the path crosses the Cape Verde Islands at 1022 and the African coast near Cape Timiris at 1039. At that point, the totality will last for more than 6 min. The path tracks eastward, then southeastward, across Africa, where the totality is the longest, and crosses the coast of the Somali Republic, near 1°S, 42°E, into the Indian Ocean. The path leaves the earth at sunset in the Indian Ocean near 13°S, 65°E.

Partial phases of the eclipse of greater or less magnitude, decreasing with greater distance from the total phase, will be visible over large areas of the Atlantic and Indian Oceans.

The editor will be very interested in any comments and/or pictures by anyone viewing this event.

A WORD OF CAUTION. Be extremely careful when viewing this natural phenomenon, as eye damage can easily occur and is irreparable. Use special equipment, not the naked eye. Also, use extreme care when using cameras.

Figure 26.--This is how the March 7, 1970, total eclipse of the sun looked. Mariners may be treated to a similar sight on June 30, 1973.

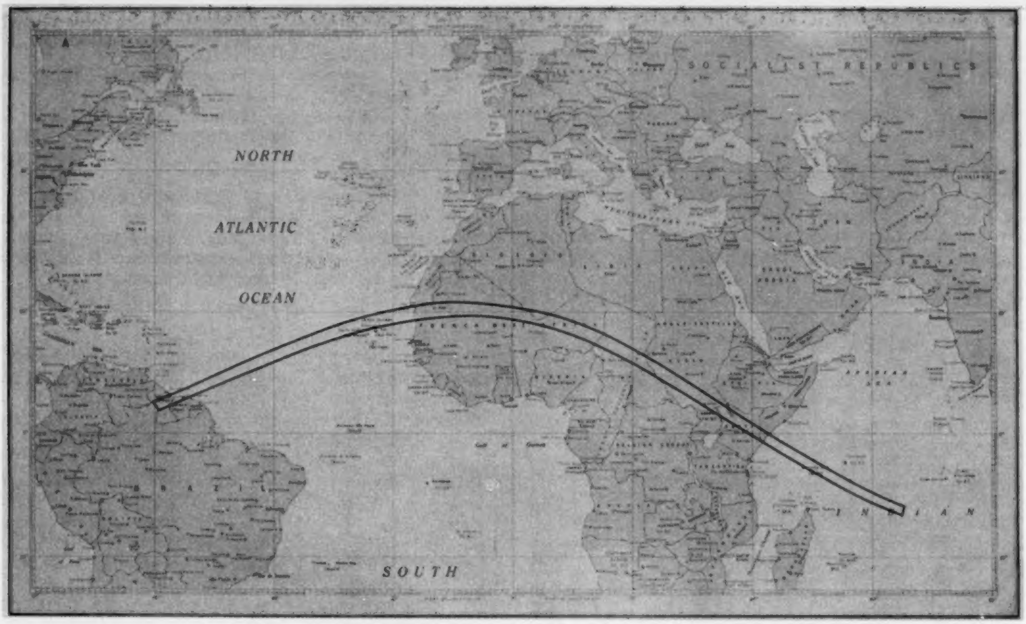


Figure 27.--Track of the total eclipse of the sun, June 30, 1973.

HOURLY TIDE DATA FOR ANCHORAGE HARBOR USERS

The National Ocean Survey is offering a new service to commercial shipping--a pilot program which provides the hourly heights of the tides for the complete year, as well as the predicted times and heights of high and low waters.

The new program is being tried out in Anchorage, Alaska, where the tide range is so great that it poses major problems for shipping in Cook Inlet. If successful, the new service may be continued annually and extended to other areas.

The hourly tide prediction tables were prepared by the Tides Prediction Branch in NOAA's National Ocean Survey. They are based on continuous tide observations at Anchorage over the past 7 yr.

The need for predicted tidal data has always existed, with the emphasis usually on the predicted times and heights of high and low waters, primarily because of space limitation in publications. Tide tables containing high-and low-water predictions are published by NOAA for most of the maritime world.

With the rapid expansion of marine activities, the need for more detailed data has grown tremendously. This is especially true in such areas as Cook Inlet, the waterway which leads to Anchorage, Alaska's main port, where commercial shipping consists primarily of oil tankers and freighters. These vessels have increased greatly in size in recent years, drawing more water and thus decreasing the amount of clearance between their hulls and the bottom. It is now uneconomical to have vessels lay-to waiting for the higher stages of the tide before passing shoals or entering ports. More accurate and detailed predictions may permit passage into those dangerous areas at times other than the maximum tidal stages.

The new tables meet this need for additional tide data and will eliminate the time-consuming task of computing hourly levels and the greater possibility of errors.

SIDE LOOKING AIRBORNE RADAR USED IN SEARCH FOR ICEBERGS

The Coast Guard is evaluating a radar system that could be useful to the International Ice Patrol's mission of recording the size and position of icebergs in the North Atlantic. The Side Looking Airborne Radar (SLAR) system was installed on a Coast Guard plane which recently completed a pre-season ice patrol flight in the North Atlantic. This system can be used day or night, and in bad weather. At the present time, a man in the aircraft is relied on to spot icebergs. He is limited by his vision and the weather conditions.

Developed in 1963, SLAR consists of three basic components: two radar antennas, one on each side of the plane, and a central system inside the plane. Each antenna emits microwaves which return to the radar antenna when reflected off an object. The radar has a 10-mi range on each side. Two continually moving strips of photographic film record the picture. What the Coast Guard must do is accurately interpret the pictures on the processed film.

Radar microwaves returned from an iceberg are usually less dense than those returned from a ship. Also, microwaves returned from ships and boats have a fairly constant density. After a pattern on the processed film is identified as an iceberg, its size is determined by a mathematical formula involving the altitude of the plane and its distance to the iceberg.

SLAR appears to have been successful so far. Determination is being made of the degree of accuracy and if SLAR is recording as much as a man.

SHIP CONDENSATION TRAILS SEEN BY SATELLITE

Numerous cases of anomalous lines have appeared in satellite pictures. These lines have been observed in both the Atlantic and the Pacific Oceans, but most frequently appear off the California coast in late spring and early summer. In 1967, Weather Bureau Western Region offices, with the cooperation of commercial airline pilots, began to investigate these lines.

One documented case is shown here. On June 27, 1967, the ESSA 2 automatic picture transmission (APT) photograph (fig. 28), taken at 1720, showed anomalous cloud lines (upper right-hand corner). The pilot of a commercial airlines flight flew over this area at 1945. He reported no clouds or vapor trails at his flight level of 31,000 ft. Below him, he observed a layer of low, thin stratus through which sunlight, reflected from the ocean, could be seen. He estimated the height of the stratus layer to be 1,000 ft above the surface. He also reported that a ship located near 35°N, 131°W, and traveling due east was clearly visible through the stratus layer. The smoke from the ship's stack was forming a "definite line of thicker clouds" in the layer of scattered and broken stratus. This condensation trail was estimated to be 2 to 4 mi wide at a point 10 mi behind the ship, and to extend 125 to 150 mi before fading out. It was drifting southward with the cloud layer.

This observed condensation trail had the same orientation as a line (a-b) in figure 28. The 1800 Surface report indicated that two ships, WHEX and WAZB, were in this area. Ship WHEX was located to the east of the cloud line and was traveling northeastward at 20 kt. Ship WAZB was traveling westward at 15 kt away from this area.

The surface analysis showed these ships to be located in the eastern sector of a large high-pressure area. At this time, 5-to 10-kt northwesterly winds, fog, and stratus, typical of the ship trail-producing regime, were reported.

Recent observations of these anomalous lines in the Applications Technology Satellite 1 data show that they are distorted and propagated by low-level winds. Once the synoptic regime become established, these lines will appear in various configurations for 2 or 3 successive days.

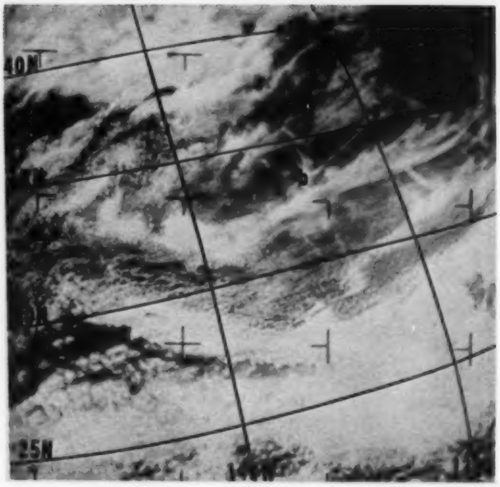


Figure 28.--ESSA 2 satellite picture showing ship condensation trails at 1720 on June 27, 1967.

SHORT-RANGE NAVIGATION SYSTEM TO BE STUDIED ON DELAWARE BAY

The effectiveness of an electronic short-range navigation system in a close channel situation will be studied by the Coast Guard. LORAN-C (LOng Range Aid to Navigation) is an electronic system used by mariners to navigate over long distances and is the most precise way to pinpoint a ship's position. The differential LORAN-C system to be studied is an adaptation of the existing system that allows a mariner to accurately fix his position to within 50 ft.

The test will be conducted in Delaware Bay, and if successful, the system could be the answer to the Coast Guard's RIHANS (RIver and Harbor Aid to Navigation System) program. The LORAN-C system is just one of the electronic type systems that will be tested.

Mariners currently entering narrow channel navigation situations use existing aids to navigation including lights, buoys, range markers, and, in some of the major U.S. ports, traffic sea lanes and the vessel traffic radar system. The test of electronic systems is part of the Coast Guard's overall plan for Marine Traffic Management. Part of that plan includes a short-range, all-weather, precision navigation system that can be used in harbors and harbor entrances to further aid the mariner against collision and accident.

RESEARCH MAY LEAD TO FORECASTING OF ICE FORMATION AND MELTING

One key part in the program to extend the navigation season on the Great Lakes is the actual study of ice itself. Ice can occur in almost as many different forms as do rocks, each with its own rate of formation and rate of melting, or breakup.

NOAA Lake Survey Center's program is divided into three distinct parts: 1) maintaining a network of ice observation posts which report on ice formation, thickness and related matters; 2) field operations, which include collection, preparation, and analysis of ice samples taken from a variety of locations; and 3) aerial observations made regularly provide information on the extent of the ice cover and on the types of ice observed.

A network of 25 ice stations, in addition to 10 in areas critical for shippers, has been setup to observe ice conditions. The scientists plan to visit an additional 21 sites to collect ice samples for laboratory analysis. Temperature measurements are being made at permanent stations and from ships operating during the winter in Lake Superior. From accumulated data, scientists hope in the future to be able to forecast ice freezeup and breakup.

Work done by Lake Survey Center scientists on the subject of ice will be of direct or indirect value to the extension of navigation season program, as well as in other areas. One phase is being done in support of the International Field Year for the Great Lakes (IFYGL), an in-depth, 1-yr study of Lake Ontario.

Part of the International Hydrological Decade--a worldwide water research effort--IFYGL will provide data for the preservation and management of all the Great Lakes.

For additional information on ice and extension of the Great Lakes navigation season see the article on page 135, titled "Great Lakes-St. Lawrence Seaway Navigation Season Extension."

OCEAN STATION VESSEL PHASEOUT

Five Ocean Station Vessels will be phased out of operation by June 30, 1974. Four are in the Atlantic and one is in the Pacific. They are Ocean Station Vessels "B," "C," "D," "E," and "N." The phase-out time table is:

"D" and "E"	June 30, 1973
"C"	December 31, 1973
"B" and "N"	June 30, 1974

These stations have been vitally important to ships and planes crossing the vast oceans. Not only have they supplied weather, winds, navigation fixes, and communication relays, they have participated in spectacular rescue operations (fig. 29). They have contributed irreplaceable data for determining the climatology of both the Atlantic and Pacific Oceans by reporting continuous data from a selected position. Monthly summaries from these vessels have appeared in the Mariners Weather Log since January 1957.

The Mariners Weather Log would like to thank the U.S. Coast Guard who operated the ships and the many National Weather Service observers that reported the weather through all types of hazardous conditions (fig. 30).

NATIONAL WEATHER SERVICE BEGINS PARTIAL OPERATION OF WEST COAST MARINE CIRCUIT

Completion of two key stations at Point Reyes, Calif., has allowed the National Weather Service to put its long-awaited West Coast Marine Circuit into partial operation. This teletype circuit makes available to the NWS, the Coast Guard, the National Marine Fisheries Service, and commercial interests a comprehensive bulletin of Gulf and West Coast area marine ship weather reports. The reports are composed of individual messages put on the teletype circuit by anyone who has radio contact with ships at sea and

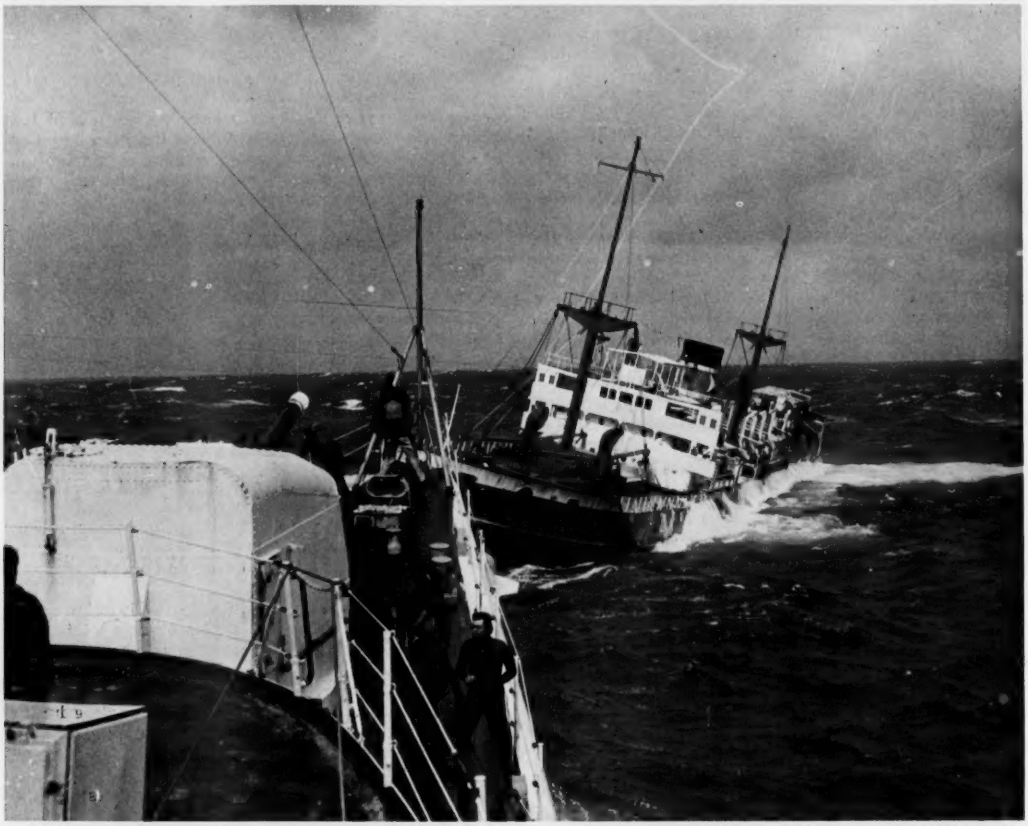


Figure 29.--The USCGC COOS BAY, returning from Ocean Station "B," skillfully rescued 12 crewmembers from the sinking British motorship AMBASSADOR while rolling up to 45 degrees in 25-ft seas with 40-kt winds. U.S. Coast Guard Photo.

Figure 30.--Ocean Station Vessels maintained position through extremely hazardous weather conditions. Pictured here, the USCGC OWASCO with 10 in. of ice. It was picked up when 65- to 70-kt winds tossed heavy spray aboard while the vessel patrolled the Labrador Sea. U.S. Coast Guard Photo.

consolidated by the NWS computer in Suitland, Md., into one bulletin with a standard abbreviated heading.

The WCMC begins its route in Texas, at Port Arthur, picks up Galveston, then goes to California, first to La Jolla, then Los Angeles, north to San Francisco, Point Reyes, and finally to Redwood City, where its data enter a multiplexed circuit to the Suitland computer. Only La Jolla has not reached operational status.

This is the first time the National Weather Service has used Model 37 teletypewriter equipment in a network configuration. This model of equipment employs the eight-level code, the American Standard Code for Information Interchange, which offers greater flexibility than other equipment allowed. Also, the network operates at 150 words/min, 50 words faster than any equipment previously used.

NOAA ESTABLISHES A MARINE ADVISORY SERVICE

A Marine Advisory Service, designed to put information on marine resource and marine environmental utilization directly into the hands of people who need it, has been established by NOAA. The new program will build upon Sea Grant advisory programs that have already been established in most coastal and Great Lakes States. The total effort will be coordinated by the Office of Sea Grant, and will bring together in a unified program the work of NOAA components and advisory services located at colleges and universities. The new marine advisory service will follow the tradition of agricultural extension, which links colleges and universities to users at the "grass roots" level.

A goal of the program is to increase the effectiveness of Sea Grant marine advisory agents who walk the waterfront and work with marina operators, port planners, fishermen, shippers, and recreational sailors.

Technical staff from all components of NOAA may be called upon as experts, appearing at workshops, helping solve problems posed by users, and participating actively in local advisory projects. To facilitate this, each component has designated a staff member to act as the marine advisory specialist at its headquarters. NOAA personnel at laboratories and field installations throughout the United States have been designated as Marine Advisory Service

representatives. They are responsible for disseminating information on NOAA products and services to local marine advisory units, and arranging for technical expertise when called upon for assistance.

The Advisory Service will address major problems facing marine operators following a planned program of technical assistance. The program is keenly interested in "feedback" from users to help improve the advisory services. Information is also passed along to personnel engaged in research and development so their efforts are placed on relevant marine problems.

To receive assistance from the NOAA Marine Advisory Service inquiries should be addressed to the following Sea Grant programs.

Alaska	University of Alaska
California	University of California, University of Southern California, California State University, Humboldt
Delaware	University of Delaware
Florida	State University System of Florida, University of Miami
Georgia	University of Georgia
Hawaii	University of Hawaii
Louisiana	Louisiana State University
Maine	Maine Department of Sea and Shore Fisheries, University of Maine
Massachusetts	Massachusetts Institute of Technology
Michigan	University of Michigan
Mississippi/Alabama	Universities Marine Center
New Hampshire	University of New Hampshire
New York	State University of New York/Cornell University
North Carolina	University of North Carolina
Oregon	Oregon State University
Rhode Island	University of Rhode Island
South Carolina	Marine Resources Center
Texas	Texas A&M University
Virginia	Virginia Institute of Marine Science, Virginia Polytechnic Institute and State University
Washington	University of Washington
Wisconsin	University of Wisconsin

In addition, inquiries can be addressed to:

NOAA Marine Advisory Service
Office of Sea Grant
U.S. Department of Commerce, NOAA
Rockville, Maryland 20852

GIANT EXPERIMENTAL BUOY MARKS THIRD YEAR REPORTING ATLANTIC STORMS

A 100-ton experimental data reporting buoy marked the third anniversary of its anchoring in the Atlantic Ocean on February 1, 1973. It has been keeping tabs on ocean-spawned storms which could endanger the mid-Atlantic states and New England.

In doing so, it established a record for longevity in the deep sea for a buoy of such size. The device is the first of a series of giant experimental environmental data reporting buoys being developed and tested by NOAA. Similar experimental buoys are reporting data from the Gulf of Mexico and the Gulf of Alaska, where they were anchored last year.

The Atlantic buoy is anchored in the Gulf Stream approximately 125 mi southeast of Norfolk, Va., in 9,900 ft of water. The buoy was deployed February 1, 1970, and since that time has been overhauled, refurbished, and refitted on two occasions with new and improved components and sensors.

The Atlantic buoy (designated EB-01 for Environmental Buoy Number 1) has already made noteworthy contributions to the weather watch along the densely-populated East Coast. The data from the buoy contributed significantly to more accurate and timely predictions of heavy snowfalls, flooding rains, high winds and seas, and destructive tides and storm surges.

The buoy is programed to check all its sensors once per hour, record the acquired data and transmit the stored data every 3 hr to the Coast Guard Radio Station, Miami, Fla., and from there to NOAA's National Meteorological Center in Suitland, Md., and finally to other users via the regular weather networks. The buoy is capable of more frequent interrogation on request when needed for critical monitoring periods.

Experience gained from the Atlantic buoy has contributed to the development of the buoys anchored in the Gulf of Mexico and the Gulf of Alaska. The EB-10 buoy in the Gulf of Mexico, located about 225 mi southeast of Bay St. Louis, Miss., has been periodically reporting environmental data since it was anchored in June 1972.

This massive buoy is designed to withstand severe weather and sea conditions, including 150-kt hurricane winds, 60-ft waves, and 10-kt currents. Its platform carries a meteorological sensor package at levels of 15 and 30 ft, a hull-mounted oceanographic sensor package, and 12 oceanographic sensor packages at various levels down to 1,500 ft. These packages will sense more than 76 individual measurements of environmental data during a routine weather reporting cycle.

The buoy in the Gulf of Alaska (EB-03), deployed in the sub-Arctic waters in October 1972, is similar in design to the EB-10. Its station in the Gulf of Alaska is providing an on-site test of the ability of the experimental buoys to withstand particularly severe environmental conditions. Meteorological information transmitted by this buoy aids weather forecasting for Alaska and the west coast of North America.

NAMES FOR TROPICAL CYCLONES, 1973

The following names are those that will be assigned to tropical cyclones that reach tropical storm or greater intensity during 1973. A new list is started each calendar year for cyclones of the eastern North Pacific (Central America west coast to 140°W) and of the North Atlantic (including the Caribbean Sea and the Gulf of Mexico). For the western North Pacific (from 140°W to the Asiatic mainland), the practice of continuing the alphabet from the previous year will remain unchanged.

Atlantic	Eastern Pacific	Western Pacific	
Alice	Ava	Wilda	Amy
Brenda	Bernice	Anita	Babe
Christine	Claudia	Billie	Carla
Delia	Doreen	Clara	Dinah
Ellen	Emily	Dot	Emma
Fran	Florence	Ellen	Freda
Gilda	Glenda	Fran	Gilda
Helen	Heather	Georgia	Harriet
Imogene	Irah	Hope	Ivy
Joy	Jennifer	Iris	Jean
Kate	Katherine	Joan	Kim
Loretta	Lillian	Kate	Lucy
Madge	Mona	Louise	Mary
Nancy	Natalie	Marge	Nadine
Ona	Odessa	Nora	Olive
Patsy	Prudence	Opal	Polly
Rose	Roslyn	Patsy	Rose
Sally	Sylvia	Ruth	Shirley
Tam	Tillie	Sarah	Trix
Vera	Victoria	Thelma	Virginia
Wilda	Wallie	Vera	Wendy
		Wanda	

MARINE WEATHER REVIEW

Smooth Log, North Atlantic Weather

November and December 1972

The SMOOTH LOG (complete with cyclone tracks [figs. 32-35], climatological data from U. S. Ocean Station Vessels [tables 10-14, 16], and gale tables 15, and 17, is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

SMOOTH LOG, NOVEMBER 1972--The storm tracks were near normal both in number and location. The mean central pressures were, possibly, slightly lower, and the tracks more southerly across the eastern United States. This would result in more easterly rather than westerly winds across the Great Lakes. The U.S. Atlantic coast to the Norwegian Sea was definitely the favorite road. One LOW center tracked to the African Coast and one into central Europe.

The location of the storm tracks are reflected in the mean pressure centers and pressure anomalies. The Bermuda-Azores High (1022 mb) was well east of its mean position, and a ridge extended throughout the Mediterranean Sea, replacing a climatic 1014-mb Low. The Icelandic Low, which climatologically has two 1000-mb centers--one in the Davis Strait and one in the Denmark Strait, southwest of Iceland--was located approximately 700 mi east of Keflavik, with a mean pressure of 994 mb. A major trough extended west-southwestward from the Low, across Iceland to the southern tip of Greenland. A second major trough extended from the tip of Greenland, southward, and then southwestward off the U.S. East Coast. This easterly shift of the major pressure centers resulted in the westerly zonal flow being shifted from northern Atlantic waters to northern Europe. The anomalies were in direct relation to the shifts of the pressure centers. A negative 13-mb center was located in the Norwegian Sea, extending to a negative 14-mb center in Siberia. Another negative 6-mb anomaly was centered at 40°N, 50°W. A positive 4- to 7-mb anomaly extended from 30°W, eastward across southern Europe and northern Africa. A horseshoe-shaped positive 4 mb was located in east-central Canada.

November averages one tropical storm every 3 yr, and, of these, half will develop into hurricanes, or, one every 6 yr. There were none this year.

Monster of the Month--A 1009-mb LOW developed in Kansas on the 1st, and by the 4th had moved eastward across the Great Lakes. At 0000 on the 4th, it was centered at 45°N, 60°W, with a central pressure of 992 mb. At that time, the E. E. PRINCE reported 40-kt gales and the LOPPERSUM had 35-kt winds to the south and southwest of the LOW. Twelve hours later, as the storm moved farther to sea and over the Gulf Stream, the pressure dropped to 984 mb. The ATLANTIC CAUSEWAY was blasted by 55-kt winds near 54°N, 59°W. The DART AMERICA and the SHEAF TYNE were rocked by 45- and 40-kt gales, respectively. By 1200 on the 5th, the LOW had raced to 59°N, 35°W, with the pressure down to 959 mb. It was really wrapped up. Several ships were involved in the cyclonic circulation. The USCGC MORGENTHAU was hammered by hurricane-force 65-kt winds and 21-ft seas, 200 mi to the southeast. The DUKESGARTH fared only slightly better with blasts of 55 kt, 350 mi southwest of the center, and the GLEN AVON suffered 45-kt gales as far as 550 mi southwest of the LOW. Other ships reported gale-force winds as far away as 600 mi in the southwest quadrant.

The LOW continued on a steady course to the northeast with the pressure dropping to a minimum of 952 mb, at 0000 on the 6th. At that time, it was located near 62°N, 34°W. The USCGC MORGENTHAU continued her northeasterly course paralleling the storm. At 0000 she was near 59.8°N, 30.0°W, still taking a 60-kt pounding while the seas had increased to 30 ft. The BORE 3 and the ERIKA DAN, both suffered through 50-kt winds and seas as high as 26 ft, all in the southeast quadrant of the storm.

During the next 24 hr, the LOW moved over Iceland and started to show its age. The pressure had risen to 971 mb and the gradient had slightly weakened by 0000 on the 7th. In the meantime, Ocean Station Vessel "I" was treated to a 55-kt hammering as the USCGC MORGENTHAU continued to follow the LOW, but the wind speed had decreased to 45 kt. The VICTORE, 400 mi south of the LOW center, was rocked by 50-kt gales, and the MAI, just south of Iceland, rolled with 45-kt gales. During the next 48 hr, the LOW moved to near 69°N, 10°E, or just off the coast of Norway. The filling process continued with a few reports of 35- to 40-kt gales in the Norwegian Sea. The storm was not yet finished, though, it spawned an offspring in the Denmark Strait on the 7th, and another south of Iceland on the 8th. They continued to grow, and on the 9th, united to form a system stronger than the aging parent. At 1200 that day, it was located near 62°N, 14°W. The PHOTINIA, which was 550 mi to the southwest, battled 50-kt headwinds. At 1600 that day, the British trawler, SSAFA 155, radioed an SOS from 130 mi off the Vestmann Islands. A giant wave had swept over the ship, damaging the bridge, rendering the rudder useless, and cutting the auxiliary motors and all lights. The vessel was also taking water. A Hercules rescue

plane of the Icelandic Defense Force, located the trawler and circled overhead, while awaiting the Coast Guard vessel AEGIR.

As the storm drifted off the Norwegian coast, another small LOW was born south of Greenland. This LOW raced eastward across Ireland and England into the North Sea, at 0000 on the 13th. The WAN CHUN, at anchor in Ymuiden, Netherland Harbor, drifted and ran aground. At that time, the central pressure had fallen to 970 mb. Again the old LOW survived, but was surpassed in strength by the interloper. This LOW was truly a killer. Hurricane wind speeds, up to 110 kt, were reported in mountainous areas of Europe. The death toll reached at least 73, according to late reports, and the East German news agency said 118 persons lost their lives. The destruction from the winds and rains amounted to many millions of dollars. The first blimp built by West Germany since World War II was destroyed. The 22,391-ton Greek bulk carrier, MASTER PETROS, was grounded in the Ems River. The killer LOW circled the original LOW, which remained stationary near 64°N, 5°E, and finally completely conquered it on the 17th.

A front across the southeastern United States had several waves form and dissipate prior to one of them developing into a 1014-mb LOW over Cape Hatteras on the 4th. The LOW moved northeastward, developing as it went. The first gale-force winds were reported on the 6th to the northeast through west of the center. At 0000 on the 7th, the QUEBEC, midway between the LOW located near 40°N, 56°W and the coast, reported 55-kt winds. At that time, the storm took a sudden turn to the south for 12 hr, then east, and again southeast prior to turning northeastward again on the 10th. Back at 1200 on the 7th, the MOBIL EXPORTER, at 37.5°N, 59.0°W, was hammered by 60-kt storm winds and 32.5-ft waves. The ANSGARITOR, 100 mi southwest of the center and about 60 mi southeast of the MOBIL EXPORTER, was rocked by 50-kt winds, 30-ft seas, and 33-ft swells. On the 8th, the LASH ITALIA, southwest of the center, and the AMERICAN LEGACY, northeast of the center, were tossed by over 40-kt gales. The 990-mb LOW was now weakening as it drunkenly wandered in mid-Atlantic. Late on the 10th, its circulation was engulfed by the following system.

A diffuse frontal system, in the midwestern United States on the 4th and 5th, attained better organization on the 6th, and a 1008-mb LOW formed west of Lake Superior. Sixty hours later, the LOW was centered over Long Island with the central pressure down to 982 mb. Record rain lashed New York City with 4.6 in. in 12 hr. This broke all records for a November rainfall. Wind gusts up to 45 kt were recorded. The buoy EB-01 reported 40-kt gales as did the ESSO MIAMI and the NINA BOWATER, south of the LOW's center. At 1200 on the 9th, the ESSO MIAMI, on a northerly course, was converging with the LOW and receiving 50-kt gales. The MELVIN BAKER and the ESSO HUNTINGTON in the same vicinity, near 38°N, 70°W, were also battered by the 50-kt gales with waves up to 19.5 ft. The LOW moved almost due east and the pressure was 987 mb at 0000 on the 11th, near 41°N, 55°W. The cyclonic circulation covered most of the western middle North Atlantic. Gale-force winds up to 40 kt were reported by many ships up to 600 mi from the center. Thirty-six hours later, at 1200 on the 12th, the JOHANN SCHULTE was headed directly into 60-kt northerlies near 48°N, 47°W. The ANDREA BROVIG, CITY OF OXFORD, and the JUNGE GARDE were regaled with winds of 40 to 45 kt, during that period. The JOHANN SCHULTE was still battling 55-kt headwinds 12 hr later.

In the next 24 hr, the storm completed a counterclockwise loop centered near 44°N, 47°W. During this period, the AMERICAN ALLIANCE and the STEFAN BATORY encountered 40-kt gales near 46°N, 40°W, north of the LOW. The LOW continued its counterclockwise motion and was located near 50°N, 47°W, at 1200 on the 15th. Ocean Station Vessel "B," the drillings rigs SEDCO and SEDNETH, the VASSILII SOURIKOV, and the VIKTOR LYAGIN, all were buffeted by 40-kt gales. The EXPORT AIDE, 700 mi south of the LOW, battled 52-kt winds and 14.5-ft seas.

At 0000 on the 16th, the LOW sped off to the west to near Belle Isle, as another LOW moved to just south of Newfoundland from the southwest. Ocean Station Vessel "B" reported 50- and 55-kt easterly winds at this time and 12 hr later. As the original LOW stalled near Cartwright, Labrador, and the second LOW continued its north-northeasterly track, Ocean Station Vessel "B" was pounded by 60-kt winds and the VASSIA CHICHKOVSKII, very close to the LOW's center near 54.5°N, 47.5°W, encountered 40-kt gales. On the next chart, the system of two LOW's started moving eastward, converging again into one LOW over Scotland on the 20th. In the meantime, many ships and coastal stations suffered 35- to 50-kt gales. These included Ocean Station Vessels "C," "D," "J," and "K." The LOW continued moving eastward into the Baltic Sea and then into northern Russia, where it was defeated by the cold land mass.

A 999-mb LOW was located on the Oklahoma-Kansas border on the 13th and moving eastward. On the 14th, the LOW center tracked up the Ohio River Valley producing northeasterly winds over the Great Lakes. Winds of 20 to 30 kt with gusts over 40 kt were recorded over parts of Illinois, Michigan, and Ohio. Port Clinton, Ohio, had winds clocked at 65 kt with gusts to 95 kt. Ashtabula, Ohio, reported winds of 50 kt and gusts to 61 kt. Toledo reported 12-ft waves. Waves of 6 to 12 ft occurred all along the south and west shore of Lake Erie. What were described as huge waves were whipped up on Lake Michigan and damaged seawalls and flooded roads and shore homes. A youth was swept off a breakwater and drowned. The high waves and water ride-up on top of the record high lake levels resulted in extensive flooding. In Michigan an estimated 8,000 persons were evacuated from their homes due to flooding. Damage was estimated at $7.5 million. In Ohio, flood and wind damage was estimated at $22 million and over 3,000 families were affected by the storm. No deaths were reported in Michigan or Ohio due to the storm, but the storm was at least partially responsible for 19 deaths in its sweep across the United States to the Atlantic. It triggered tornadoes in Texas, heavy rains in the northeast, and up to 18 in. of snow in Vermont and Maine. Flash floods occurred in many areas.

As the storm passed off the U.S. East Coast on the 15th, it produced heavy rains along the coast and snow in northern New England. A houseboat was overturned off Elizabeth City, N.C. The Coast Guard

rescued the couple who were on board. The SEA MAID and the SHOZEN MARU reported 35-kt gales ahead of the cold front accompanying the LOW. The WILMINGTON GETTY, at 34.8°N, 54.6°W, was battered by 58-kt westerlies. The LOW, now down to 983 mb, followed a northeasterly course, and, at 1200 on the 16th, was near 49°N, 51°W. The EDE SOTTORF, ESSO GHENT, and the USCGC BOUTWELL were all treated to 35-kt gales during this time. On the 16th, this LOW combined with the previously described storm and both moved easterly as one storm, on the 17th.

On the 0000 chart for the 17th, a 1008-mb LOW was analyzed off Savannah, Ga. Twelve hours later, the pressure had dropped to 997 mb and a ship reported 40-kt gales just to the north of the storm. At 0600 on the 18th, the PORTLAND rode out 60-kt northerlies and 24.5-ft swells about 100 mi west of the storm. Nearer the center, the KENAI PENINSULA was lashed by 56-kt winds. By 1200 on the 18th, the LOW was located near 39°N, 66°W, with a pressure of 985 mb. Ocean Station Vessel "H" was battered by 50-kt winds, and a nearby ship reported 23-ft seas. The OCEANIC, just off Wallops Island, Va., on an easterly course, had to contend with 40-kt northerly winds. The storm reached the Grand Banks, off Newfoundland, on the 19th. The AMERICAN LEGACY, MIJDRECHT, and USCGC TANEY were pounded by 45- and 50-kt gales with seas up to 23 ft in the southwest quadrant, as the storm passed their positions. The drilling rig SEDNETH was hammered by 60-kt northerlies and waves of 21 ft.

The next 48 hr found the LOW moving eastward and then southeastward with a slight filling. The pressure was 989 mb at 1200 on the 21st. The gradient had weakened, and 40-kt winds were the strongest reported by the AMERICAN LEGACY, USCGC DALLAS, and the VELAY. The ITTERSUM also encoded 40-kt winds and was rocked by 33-ft swells, south of the LOW center. On the 22d, the storm passed over the Azores and the NORDENHAM was hounded by 45-kt gales. The LOW was now filling rapidly, and its last vestige was noted near the Canary Islands, on the 26th.

At 0000 on the 23d, a 998-mb LOW developed near 36°N, 65°W. Later that day, the AMERICAN LEADER, at 42.0°N, 58.5°W, was treated to 48-kt gales and 19.5-ft seas. By 0000 on the 24th, the 972-mb LOW was southeast of Newfoundland. SEDCO I recorded 50-kt winds as the LOW passed its position. The FERNDALE, 200 mi south, also found the 50-kt wind isotach and 19.5-ft seas. Twelve hours later, the storm was really tight and SEDCO I, SEDNETH I, and the JUDITH SCHULTE reported 50- and 55-kt storm winds. On the 25th, the WALTER HERWIG and the RUHRSTEIN, on opposite sides of the LOW, encountered the same 50-kt isotach. The LOW continued moving northward and passed over Kap Farvel, late on the 25th. Ocean Station Vessel "B" reported 50 kt as the storm passed to the east. As it moved up the Denmark Strait, the storm became a very elongated trough and then regenerated north of Jan Mayen Island.

This innocent little storm was born near 42°N, 49°W, in the trough of a low-pressure area that was moving through the Denmark Strait on the 25th. The central pressure of the LOW, at that time, was 1002 mb. A few minimal gale-force winds were already being reported. On the 26th, the storm was deepening and racing north-northeastward. Ocean Station Vessel "C" reported 52-kt winds and "D" had 40-kt gales as the storm passed west of their positions. At 1200 on the 27th, the central pressure had dropped to 966 mb and the LOW was located just south of Iceland. The CARREL and the USCGC BOUTWELL, which were near 53°N, 30°W, and 55°N, 30°W, respectively, were hammered by 50-kt gales. At 1800, the BOUTWELL (54.1°N, 30.5°W), quite a distance from her Ocean Station "C" position, combated 61-kt winds and 29.5-ft seas. The ATLANTIC STAR, C. P. AMBASSADOR, MANCHESTER CONCEPT, RITVA DAN, and Ocean Station Vessels "C" and "I," all south of the storm, were buffeted by 40- or 45-kt winds. The CARREL and Ocean Station Vessel "C" reported waves up to 25 ft. On the 28th, as the LOW passed over the Faeroe Islands, Ocean Station Vessel "J" suffered from 50-kt winds and 25-ft swells. The tight gradient and strong winds passed into the North Sea. Danish helicopters had to rescue 53 men from the drifting British oil rig, OCEAN TIDE, which was being towed. The LOW continued its eastward movement but filled as it passed into the Gulf of Bothnia.

Casualties--The 15,854-ton AMERICAN LEGACY collided with the drilling platform PENTA, in dense fog at Havre on the 2d. She lost the starboard anchor and chain; they were eventually recovered. The 16,987-ton Liberian carrier THEOMANA reported damage to deck and machinery due to heavy weather. The NEW WESTMINSTER CITY (16,704 tons) grounded in fog off Penarth Head, at the entrance to Cardiff docks, on the 3d. A heavy gale split the 7,600-ton Canadian-registered MICHIPICOTEN, near Anticosti Island, Gulf of St. Lawrence, on the 17th. She was in tow of the tug KORAL, when she broke in two. The bow sank on the 17th, and the stern on the 18th. The Cyprian steamer, SANTA EIRINI, 2,006 tons, reported into Brest on the 23d, with a list reportedly due to heavy weather.

SMOOTH LOG, DECEMBER 1972--The primary storm track across the North Atlantic was not hard to determine this month. It was fairly diffuse coming across the North American continent, but converged off the U. S. East Coast. The primary track then extended east-northeastward from south of Nova Scotia, to between Iceland and Scotland, and into the Norwegian Sea. A secondary track came out of Canada to south of Kap Farvel and up the Denmark Strait. One LOW raced from the Azores, across Iceland, and near the Svalbard Islands. No significant storms penetrated into the European continent south of 50°N. This compared favorably to the main climatic tracks, except in the Mediterranean area.

The configuration of the mean sea-level pressure over the ocean was very near the climatic pattern. The Icelandic Low was at 62°N, 30°W, slightly east of its normal location. The mean pressure was 985 mb, significantly lower than the normal of 1000.7

mb. The center of the Azores High was almost exactly where climatology places it, except the central pressure was 1025 mb, 4 mb higher than normal. The result of the pressures of the Low being lower, and the High, higher, was a 20-mb tighter gradient. To add to this tight gradient in the north-south direction, there were two closed high-pressure areas where normally there are only ridges; one in central Canada and one over Romania. Therefore, the gradient in the east-west direction, out of the Low center, was greater.

Needless to say, there were large pressure anomalies. A negative 16-mb anomaly was centered southwest of Iceland at 61°N, 24°W. The three major positive anomalies were: 14 mb near 47°N, 22°E (Romania); 11 mb near 55°N, 71°W (central Quebec); and an elongated 5 mb along 30°N, from 10° to 60°W (approximately from Bermuda to Morocco). These pressure differentials and the tighter gradient help account for the concentration of storm tracks and the lack of storms into continental Europe, the Mediterranean Sea, and North Africa.

Tropical cyclones rarely occur during December. In the 30-yr period since 1942, only two have been recorded, and only one of these reached hurricane strength.

From the discussion above, it is probably obvious that there would be numerous storms across the North Atlantic, and that they would be more severe than usual. Indeed, this was true. On November 30, a front was off the U.S. East Coast with a small wave in the Gulf of Mexico. By December 1, this wave had raced across Florida and up the East Coast. As usually happens, the LOW deepened significantly as it passed the vicinity of Cape Hatteras, and at 0000 it was just east of Norfolk with a central pressure of 1003 mb. Twenty-four hours later, at 0000 on the 2d, the LOW was over Anticosti Island in the Gulf of St. Lawrence at 962 mb. The drilling rig, SEDCO 1, reported 50-kt winds and 15-ft seas, the ADMIRAL CALLAGHN was buffeted by 45-kt gales and swells of 15 ft. At 1200 on the 2d, only 12 hr later, the central pressure had dropped to 948 mb, near Hamilton Inlet. The MANCHESTER QUEST was pounded by 50-kt winds with seas of 20 ft and swells of 33 ft, near 53°N, 47°W, almost due east of the storm's center. Ocean Station Vessel "B" fought winds of 58 kt, and the ship VGBZ battled 45-kt gales. The TOPDALSFJORD experienced 40-kt gales, and the DART ATLANTIC, farther to the southeast, felt 35-kt gales. Many coastal stations were pounded by 35- to 40-kt winds. The 3,318-ton Israeli motor vessel LEORA proceeded to Miquelon Island to renew lashings for containers on the foredeck, broken by very bad weather. At 1500, the USCGC BOUTWELL measured 60-kt westerly winds and 24.5-ft seas near 51.4°N, 39.9°W.

In the next 24 hr, there were 29 reports of winds of 35 kt or greater in the vicinity of the storm, mostly south and east of the center. On the 3d, the following ships battled 50- to 60-kt winds, accompanied by seas and swells up to 40 ft: the USCGC BOUTWELL, EMILIA RUSELLO, PHOTINIA, and ZABRZE. These higher winds and waves were 300 to 800 mi south and east of the LOW's center. At 0600 on the 3d, the storm spawned another center on the front, about 120 mi southeast of Kap Farvel. This new LOW center raced off to the east with the front, while the parent LOW remained stationary about 250 mi southwest of the Cape. With the double low system, the gradient loosened slightly and only one ship, the ZABRZE, reported battling 60-kt winds and 36-ft seas. The C. P. EXPLORER, CHEVRON AMSTERDAM, and YOULIOUSS YANONISS, all were hounded by 45-kt gales, and seas or swells up to 33 ft. On the 4th, the new LOW had developed two additonal centers, and the parent low, now south of Greenland, was moving eastward and rapidly filling. The Greek-registered GOLD COIN (1,957 tons) sent out distress signals in the English Channel out of Europoort. A GOLD COIN liferaft with five bodies was recovered. Twelve other crewmembers are missing. Gales were reported in the Channel. On the 5th and 6th, a broad band of high winds stretched from shore to shore between 45° and 55°N. The AMERICAN LEADER, CAPE FRANKLIN, and the PECAN all battled against 50-kt winds and seas to 25 ft, from Newfoundland to Ireland. The CHRISTITSA battled 50-kt winds, along 48°N for over 24 hr. One ship, reporting only a three-letter code, was rocked by 33-ft waves. At this time, the three LOWS were moving eastward and filling. Gale-force winds continued to be reported through the 7th. Further disintegration continued on the 8th and 9th, as the new diffuse LOWS were over the Barents Sea. On the 10th, the 10,381-ton Liberian motor vessel GEM returned to Dunkirk with extensive weather damage and the no. 4 hold flooded.

On the 6th, a 1010-mb LOW that developed in the midwest on the 5th moved across the Great Lakes. By 1200 on the 7th, it was centered over Cape Chidley with a pressure of 982 mb. Winds of 40 kt were being reported ahead of the front, as it passed off the coast. Among these reports were Ocean Station Vessels "B" and "H" and ship VGBZ. On the 8th, the original LOW moved slowly northeastward, and a new LOW was spawned over the tip of Greenland. A very tight gradient (6 mb per 100 mi) had developed, and the winds were blowing in direct proportion. Only a few ships reported in the area, but the ANARIS and the USCGC HAMILTON were banged by 50-kt winds, with the ANARIS reporting 33-ft seas farther to the east.

On the 9th, the two LOWS registered the same pressure of 967 mb, as they straddled southern Greenland. The NANOK S., east of Kap Farvel, was rolled by a 60-kt crosswind, and the USCGC BOUTWELL and HAMILTON, both near 51°N, 48°W, reported up to 55-kt gales and 25-ft seas. At 1200, the ANARIS was making little headway, bucking directly into 70-kt hurricane-force winds and seas of 50 ft. Early on the 10th, both these LOWS were unidentifiable and a new one formed on the front, farther east over Iceland. In this process, the central pressure had risen to 974 mb with a slackening of the gradient. Winds of 45 kt were still occurring along 50°N. At 0000 on the 10th, another LOW had moved up the U.S. coast and was over Newfoundland. It moved rapidly northeastward and 48 hr later was centered 150 mi south of Iceland with a 944-mb center. In the meantime, the 974-mb LOW over Iceland on the 10th moved southwestward and was again near Kap Farvel. The WEATHER MONITOR, near 58.5°N, 14.0°W, reported 55-kt gales at 0000 on the 12th.

A third LOW followed on the heels of the second, out of the U.S. East Coast late on the 10th. By 0000 on the 12th, it was located near 47.5°N, 37.0°W, with a pressure of 972 mb. Ocean Station Vessel

"D" was pounded by 60-kt winds as the LOW passed to the north. As this new LOW moved northeastward, it absorbed the two LOWS which preceded it. At 0000 on the 13th, the pressure was 944 mb. On the 12th and 13th, high winds were reported all across the North Atlantic, north of 40°N and south of 55°N. Included among these reports was Ocean Station Vessel "J", which was hammered by winds from 45 to 65 kt and mountainous waves of 40 to 50 ft. The ORE MERCURY located 65-kt winds near 48.5°N, 30.2°W, and the SUNIMA could only struggle against 60-kt winds and 47.5-ft seas. The TAIFUN, traveling eastward, north of the Azores Islands, was hounded by 50-kt winds. The UPDV, just east of Newfoundland, rode out 60-kt winds. The LOW continued moving northeastward, as a wave that had formed near the Azores on the 13th moved north, and a lessening of the gradient over the whole area occurred. The USCGC HAMILTON, having been relieved at Ocean Station Vessel "B" by the USCGC DUANE, was slowly plowing southward through heavy seas and high winds. She had been contending with these since the 8th. By the 15th, the LOW had filled considerably and moved into the Zemlya Sea.

Monster of the Month--The "midwife" of so many Atlantic storms, the Texas-Oklahoma Panhandle delivered a 1013-mb depression on the 12th. By 0000 on the 13th, it had grown to 1005-mb and was over the Great Lakes. It was not until 1200 on the 14th, that the LOW became of age and showed its true character. At that time, the LOW had raced due east from Nova Scotia and was near 46.5°N, 41.0°W, with a central pressure of 960 mb. The SSG, 400 mi to the south-southwest, was headed directly into 65-kt hurricane-force winds. She was also being rocked and pounded by 35-ft seas and 40-ft swells. She was not alone as the LOVERVAL, near 43.5°N, 37.5°W, had 60 kt, the ECKERT OLDENDORFF near the SSG, only experienced 55 kt, and the BUNTENTOR, a mere 50-kt winds. Ocean Station Vessel "D" was managing to stay close to her station and contend with 70-kt hurricane-force winds and 35-ft seas. The West German motor vessel RUMBA reported that she was in distress 200 mi southeast of Cape Race, Newfoundland, due to locomotives adrift in her lower holds. A Canadian Forces helicopter rescued 12 crewmen from her decks. Three locomotives were lost and others damaged. The vessel subsequently arrived at St. Johns in tow of SMIT-LLOYD 103. The following vessels reported winds of 60 to 65 kt in addition to those already mentioned: the AMERICAN ACE, SEALAND GALLOWAY, and the GREAT REPUBLIC. Ocean Station Vessel "D," about 300 mi southwest of the center at 1800, must have been tossed every way but upside-down by the 85-kt winds and 54-ft seas she experienced.

On the 15th, the LOW started tracking to the northeast at a slower pace. By 0000 on the 16th, the storm was located at 52°N, 32°W, and its lowest pressure was 946 mb. The strongest wind band remained in the southwest quadrant with winds over 50 kt being reported as far as 600 mi from the center. The BUNTENTOR, ECKERT OLDERDORFF, LOVERVAL, and Ocean Station Vessel "D" had no respite from 60- and 65-kt winds. A new ship joined their ranks, with 70-kt winds and 52-ft waves at 46°N, 36°W. The storm was dominating the whole North Atlantic, north of 35°N and south of 60°N. On the 16th, the LOW started to fill; it rested by making a small loop near 50°N, 30°W. She was still packing a big punch as the ATLANTIC COGNAC reported being walloped by 90-kt winds at 50°N, 36°W, about 150 mi southwest of the center. The C. P. VOYAGEUR reported 50-kt and the UYLG 60-kt winds, 250 and 400 mi, respectively, west of the LOW. Five hundred miles to the south, the ECKERT OLDERDORFF was still fighting 50-kt winds and 30-ft seas, as was the HOFCHST, about 500 mi farther south. The 2,009-ton CAPE SABLE, just off Cabo Finisterre, sank on the 17th, after cargo shifted in heavy swells. Thirteen crewmen are missing. The LOW was again tracking northward and then northwestward to combine with another LOW near Kap Farvel on the 18th that had tracked out of the Gulf of St. Lawrence.

A wave on the polar front formed in Georgia on the 14th. It moved northeastward up the coast and, early on the 16th, was off the Delmarva Peninsula with a pressure of 1000 mb. To the north, off Long Island, the GYPSUM PRINCE and the KUNGSHOLM reported 45-kt gales with rain and thunderstorms. Wind gusts up to 45 kt were reported along the New England coast with some surf and wind damage. The SOHIO INTREPID, at 36.7°N, 70.5°W, fought 60-kt winds from the west-southwest. At 0000 on the 17th, she still reported 50-kt winds, but the seas were slight. This was only the beginning. On the 17th at 1200, the pressure had dropped to 962 mb over Anticosti Island, and winds up to 50 kt were being reported to the east, south and southwest of the center. The ship reports included the ATLANTIC CHAMPAGNE, ATLANTIC COGNAC, BAKAR, EDINBURGH CASTLE, EURPOA, GREAT REPUBLIC, MANIPUR, MERSE LLOYD, MINERAL OUGREE, PHYLLIS BOWATER, SEDCO, SEDNETH, USCGC DALLAS, and Ocean Station Vessel "H."

The LOW tracked northeasterly and by 0000 on the 19th had absorbed the previously described LOW, and was then over Kap Farvel at a pressure of 950 mb. The ELBE EXPRESS and Ocean Station "B" braved 65- to 50-kt winds reporting seas and swells to 33 ft. The LOW continued into the Denmark Strait with only mild gales of 45 kt being reported. Many of these reports included snow showers with temperatures near freezing or below. The northeast and eastward movement continued at a fast rate for the Arctic and on the 22d the LOW was well into the Barents Sea.

This LOW, born in the deep south over Georgia on the 22d, followed in the foot tracks of many others and raced up the East Coast at an average speed of 50 kt. At 0000 on the 23d, the pressure was 992 mb and centered near 45°N, 61°W. As the storm passed south of Newfoundland, the GORREDYK and SEDCO I and J reported 40- to 45-kt gales. The LOW passed directly over Ocean Station Vessel "C," at 0000 on the 24th, and the DUNBLANE was battered by 50-kt winds and 33-ft swells near 50°N, 41°W. Twelve hours later, she was still battling 50-kt winds. The ATLANTIC STAR, JUDITH SCHULTE, MANCHESTER QUEST, and MESKUPAS ADOMAS reported 50- and 55-kt winds within a 500-mi radius of the storm. The ATLANTIC FOREST battled 60- to 65-kt hurricane-force winds for over 6 hr, about 800 mi south of the

Figure 31.--Heavy surf drives the dragger ALTON A and the 44-ft Coast Guard utility boat, which attempted to rescue the fishing vessel, aground at the mouth of Casco Bay on December 4. Charles H. Merrill Photo.

center. Ocean Station Vessel "C," at 0900 on the 24th, after the center passed, was engulfed by the 65-kt winds in that violent band.

The storms during this time did not develop the large area of circulation and influence as those earlier in the month, as several were located in the North Atlantic at the same time. The LOW tracked first toward the northeast, and then the north, and was located south of Iceland on Christmas Day. It passed over Iceland, early on the 27th, and into the Norwegian Sea, on the 28th, where it became part of the general low-pressure trough.

This storm formed near Cape Hatteras as a 1007-mb LOW on the 23d (fig. 33), fast on the heels of the previous storm. It took a more easterly course, and at 1200 on the 24th was near 41°N, 60°W at 1000 mb. The wind report from the CARCHESTER was received as 90 kt, 100 mi east of the low center. The storm continued tracking mostly eastward and was the southernmost of the significant storms this month, except for a LOW that formed near the Azores and moved northward on the 13th. At 0000 on the 26th, this 970-mb LOW was at 46.5°N, 26.0°W. The ALSTER EXPRESS reported 50-kt winds and 26-ft swells at 42.0°N, 33.5°W. The AMERICAN LEGACY, at 45°N, 25°W at 1200, was involved with 65-kt winds driving 49-ft seas, and the visibility was only 50 yd. Twenty-four hours later, the LOW, now at 966 mb, was 400 mi due west of Brest. Ocean Station Vessel "K" had been battling 45- to 50-kt winds, and up to 16-ft seas and 30-ft swells. Cape St. Vincent, Portugal, reported 60-kt southwesterly winds. As the LOW moved toward Lands End and the Irish Sea, it was filling but had lost none of its punch. Ocean Station Vessel "K" was still recording 45-kt gales, and the seas had risen to 46 ft. Nearby, a ship reported 55-kt winds, but no wave heights. On the 29th, the storm stalled over the English Channel and a new LOW formed on the associated front near Sardinia, in the Mediterranean Sea. Within a few hours this new LOW dominated and drifted in the vicinity of Sardinia for several days.

A LOW formed off Norfolk, Va., on the 27th and deepened rapidly as it moved northeastward. By 1200 on the 28th, the central pressure was 966 mb and located south of St. John's, Newfoundland. SEDCO I reported 50-kt gales as it passed. The tightly wound system sped northward, and SEDCO J was pounded by 55-kt winds in the southern quadrant. To the east, the USCGC INGHAM found herself battling 60-kt winds and 26-ft seas at 0300. Ocean Station Vessel "B" had 50-kt northerly winds on the west side of the LOW. This speedster wasn't slowing in its plunge to the northeast. The LOW had an average speed of 45 kt in the last 24 hr, as it passed over Ice-

land at 1200 on the 29th. Ocean Station Vessel "I" was treated to 60-kt winds, 33-ft seas, and swells of 33 ft from 180° and 40 ft from 250°. The LOW continued its dash to the Barents Sea where it combined with another system. On the way, Ocean Station Vessel "M" was swept by 50-kt gales and 33-ft seas. Winds up to 50 kt were reported by many islands and shore stations along the Norwegian coast.

Casualties--The 12,638-ton tanker AMOCO LOUISIANA inbound to Texas City was in a collision with the 16,683-ton Norwegian bulk carrier FOSSANGER, in heavy fog. Both vessels experienced bow damage but no injuries. The 20,889-ton British tanker VITTA ran aground in heavy fog in the New York East River. The dragger ALTON A (fig. 31) was driven ashore on Trundy Point, at the mouth of Casco Bay, Maine, late on the 4th. The wooden vessel, which was holed, had to be salvaged. A 44-ft Coast Guard utility boat was also driven ashore while attempting to rescue the ALTON A. The 3,385-ton British motor vessel SUSAN CONSTANT bound for Stephenville, reported drifting with ice in the Strait of Belle Isle on the 11th. The icebreaker MANCHESTER CRUSADER escorted her to open water on the 12th. The 550-ton Swedish motor vessel NOVA and the 15,929-ton Greek motor vessel THEOFANO LIVANOS collided in fog off southern Sweden. The NOVA sank, but the crew was saved. THEOFANO LIVANOS sustained one dead and leakage in one ballast tank. The SAN ROBERTO, 7,863-ton Panamanian motor vessel, arrived at St. Michaels Inlet on the 16th, with weather damage. Ice in the St. Lawrence Seaway fractured portside shell plating and buckled a bulkhead on the 14,766-ton Liberian motor vessel HELENE. The 3.035-ton Liberian motor vessel IL-KON TAK arrived at Jacksonville from Antwerp on the 26th, with heavy weather damage, cracked forepeak, and no freshwater.

Smooth Log, North Pacific Weather

November and December 1972

SMOOTH LOG, NOVEMBER 1972--The primary tracks were out of Manchuria and the Yellow Sea, across northern Japan, and into the Bering Sea or paralleling the Aleutian Islands and then into the Gulf of Alaska. Another favorite track was out of the central North Pacific into the Gulf of Alaska. A few of these then turned southeastward along the U.S. West Coast.

The 994-mb Aleutian Low was near its mean position but 6-mb deeper than normal. The Pacific High (1023 mb) was almost a duplicate of its climatological counterpart (1021 mb). The elongated oval High stretched across the Pacific, centered on 30°N, from the U.S. West Coast to 160°E. The larger pressure anomalies were due to the lower pressure of the Aleutian Low and higher pressure of the Pacific High. A negative 6-mb anomaly was centered near 54°N, 175°W, in the southern Bering Sea. A second negative anomaly of 7 mb was near 49°N, 135°W, south of the Gulf of Alaska. Positive 2- to 3-mb anomalies occurred from shore to shore, roughly between 20°N and 35°N. A positive 12-mb anomaly was located in eastern Siberia, reflecting an intensification of a ridge of the Siberian High. This is significant, as only one LOW originated out of that area, north of 50°N.

There were three tropical storms in the North Pacific; Liza in the eastern, and Pamela and Ruby in the western. Liza reached tropical storm strength; Pamela, typhoon strength; and Ruby, supertyphoon strength. In the eastern North Pacific, one tropical storm can be expected each 3 yr with a rare one reaching hurricane intensity. Liza is described in the article "Eastern North Pacific Tropical Cyclones, 1972," appearing in the March 1973 issue.

The first significant storm of the month, as far as winds were concerned, developed as a 1007-mb LOW on the 5th near 43.5°N, 154.0°E. At 0000, two reports of 35-kt winds in the southwest quadrant were received. At 1200, the GEORGIANA, near 40°N, 155°E, was buffeted by 45-kt winds. The LOW continued its northeasterly track with the center passing up the Aleutian Island chain. At 1200 on the 7th, the 978-mb LOW was near 55.5°N, 158.5°W. The VANTAGE HORIZON, 550 mi to the south, was pounded by 60-kt winds with 25-ft seas and 30-ft swells. Twelve hours earlier, the HONSHU MARU and PIRAN were rocked by 40- and 45-kt winds. The storm turned eastward in the next 24 hr, and then southeastward as it passed through the Gulf of Alaska. On the 8th, the ROMANIC, heading northeastward, was rocked by 55-kt northwesterly winds, accompanied by 50-ft seas. In addition, the report indicated 40-ft swells. The OREGON MAIL, heading northeastward, was buffeted by 60-kt winds at 0000 and 24 hr later still had 50-kt winds. She was also contending with seas of 25 to 32 ft and swells up to 39 ft. The 9th saw the LOW slightly weakening. Cape St. James reported 50-kt gales ahead of the front, and the MANDARIN VENTURE and OREGON MAIL still had 45- and 50-kt winds, 400 to 500 mi behind the LOW. As the storm paralleled the coast, moving southeastward and then inland north of San Francisco on the 11th, it filled rapidly and no longer was a danger to shipping.

Returning again to the 5th, this time at 1200, a 1016-mb LOW was discovered in the Yellow Sea. Twenty-four hours later, this racehorse was near Hakodate, Japan. The pressure had dropped to 994 mb as it sped northeastward at over 40 kt. By 1200 on the 7th, it had slowed its forward pace, but the pressure was now 964 mb. Two stations in the Kuril Islands were hit by 50-kt winds. The SHUNTO MARU bounced with 55-kt winds and 35-ft waves, while the KENYU MARU, farther south, had to contend with winds of only 45 kt. The GEORGIANA, at 41.7°N, 172.5°E, and the YGUAZU, at 46.5°N, 164.2°E, both southeast of the LOW but one ahead of and one behind the front, were pounded by 60-kt winds. The former also reported 39-ft swells. The storm was near 51.5°N, 162.0°E, at 0000 on the 8th, with a central pressure of

960 mb--its lowest--and wound like a spring. It let off some of its energy by battering the WAKATOSAN MARU with 50-kt winds, 30-ft seas, and 50-ft swells. This occurred 450 mi south of the LOW. The YGUAZU continued to receive the 60-kt battering. During the next day, the KAKUKO MARU and SOHIO RESOLUTE were both treated to gales of 50 kt, but the seas in the area to the south had dropped to 15 ft and the swells to 30 ft. As the storm entered the Bering Sea, the icy waters aged it rapidly and by the 12th it no longer existed.

Early on the 9th, a wave formed on the polar front in the vicinity of 33°N, 173°E. Late on the 10th, the GEORGIANA was again caught in high winds of 55 kt and 32-ft seas near 45°N, 164°W. On the 11th, the LOW was gaining strength and was close to 46°N, 167°W. The CALIFORNIA received a 60-kt beating at 1800 that day. The GEORGIANA, following the LOW as it moved northeastward, stayed in the same 55-kt wind band, until after 0000 on the 13th. On the 12th, the 982-mb LOW turned eastward and then to the southeast and started weakening. By the 14th, it was off the northern California coast with only minimal gale-force winds; it was causing rain in California and Nevada.

At 1200 on the 14th, a new system was assembling in the Yellow Sea storm factory. The 992-mb LOW did not become significant until it had moved east-northeastward over Japan and was near 43.5°N, 155°E, at 0000 on the 16th. At that time, the SHOMEI MARU and the SHORYU MARU encountered 40-kt winds, about 180 mi to the southwest. The DOVER MARU, which was ahead of the cold front about 600 mi to the south, basked in 22°C southerly winds of 40 kt. At 0000 on the 17th, the LOW was registering 964 mb and moving to the northeast. These ships reported the following winds: BANARIO, 55 kt; CHUETSOSAN MARU, 50 kt; and the JAPAN ERICA, 45 kt; all in the southwest quadrant. Ahead of the front in the southeast quadrant near 42°N, 174°W, the SYUKO MARU also was involved with the 55-kt storm wind band.

On the 18th, the LOW absorbed remnants of extratropical Pamela which had moved into the Bering Sea. Between the 18th and the 20th, the storm executed a counterclockwise loop in the vicinity of Fox Island. The DAISHOWA MARU, HARIMA MARU, JAPAN AZALEA, KASHIMA MARU, KASUGAI MARU, and the VYSSOTSK reported 40- to 45-kt winds during that time. The ANADARA, at 45°N, 175°E, encountered 50-kt gales accompanied by 25-ft seas, and swells of the same height. On the 20th, far to the north of the LOW near 61.5°N, 179.6°W, the Japanese fish factory ship, SOYO MARU, battled 50-kt winds with heavy snow. Close by, Cape Navarin was frozen by by -12°C north winds of 70 kt.

The LOW continued its northeasterly movement up the Aleutian Islands on the 21st, slowly filling. On the 23d, it moved into Alaska and by the 24th had circled over the Bering Strait and dissipated into only a trough.

A 1008-mb LOW developed near 30°N, 142°E, on a cold front extending out of the last described low-pressure area. It moved east-northeastward and then northeastward, slowly developing until, on the 24th, it was near 47.3°N, 158.0°W, with a central pressure of 960 mb. At that time, it started to show its true character. The HONSHU MARU was hit by 45- to 55-kt winds, late on the 23d and on the 24th, 250 mi west of the LOW. The JAPAN CARNATION and the KINKO MARU, to the south and southwest were treated to 50-kt gales. At 1200 on the 24th, the buoy EB-03 reported 40-kt east winds as did Ocean Station Vessel "P." On the 25th, the MOBILE and the JOSEPH D. POTTS were pounded by 50-kt winds as the storm proceeded northeastward into the Gulf of Alaska. On the 26th, as a last dying effort, it kicked the MOBILE with 75-kt hurricane-force winds, near 55.5°N, 141.2°W, prior to entering Yukon.

An old, weak, low-pressure system drifted out of China and, on the 24th, started to regenerate over the warmer waters off Japan. The pressure at 1200 was 995 mb. By the 26th, it had moved to 47.5°N, 179.5°E, and the pressure was 980 mb. The MATSUSHIMA MARU encountered 45-kt gales near the tri-point of the frontal occlusion, many miles south of the LOW. On the 26th, the LOW passed over the Aleutian Islands into the Bering Sea and, contrary to the usual, continued deepening to a pressure of 956 mb while moving to 60.7°N, 173.5°W. The SOYO MARU, which had moved south to near 56.9°N, 172.8°W, was blasted with heavy snow driven by 55-kt winds. The CITADEL, at 0600 near 54.1°N, 154.5°W, reported 60-kt winds. Twelve hours later, at 1200 on the 28th, the KASHIMA MARU, now heading southwestward, was pounded by 60-kt headwinds driving intermittent heavy snow. The air temperature was a bone-chilling -1°C. If that wasn't bad enough, the weather station at Mys Shmidta, on the Chukchi Sea Coast, reported 80-kt winds with a -25°C temperature. Although the storm was rapidly dying on the 29th, several Siberian shore stations reported winds of 50 to 70 kt. By midday on the 30th, all evidence of any closed cyclonic circulation had disappeared.

In the western North Pacific, Pamela popped up on the 4th, about 300 mi east of the Philippines. The tropical storm moved due westward and intensified to typhoon strength as it moved across Samar on the 5th. Pamela retained her strength as she moved through the islands. Before the 5th was over, she was into the South China Sea. The following day, Pamela began to pick up strength as she churned west-northwestward. The typhoon reached peak intensity on the 7th, when maximum winds of 110 kt, with gusts to 150 kt, were found close to her center. At this time, she was turning northward. She reached the south coast of Hainan early on the 8th. Later that day, she moved northward into China and weakened but did not dissipate. The 8,343-ton Panamanian motorship VANMINT, in Hong Kong Harbor to be broken up for scrap, either broke adrift or dragged her anchor and went aground on the southern shore. Two watchmen on board were unhurt.

Pamela turned extratropical and recurved into the Yellow Sea, on the 9th. Within 24 hr, she had raced across Japan, and at 0000 on the 11th, was near 43°N, 158°E with a pressure of 972 mb. Many ships knew the storm was in the area as 35- to 50-kt gales were reported as far as 900 mi to the south and southwest. The BLUE BIRD was battered by 50-kt freezing winds and heavy snow, 200 mi to the north. The VAN ENTERPRISE, at 50°N, 179°E,

also enjoyed 48-kt gales from the southeast. The ALASKAN MAIL, 450 mi southwest of the center, was rocked by 60-kt winds, 25-ft seas, and 41-ft swells. At 0000 on the 12th, the LOW was near 49°N, 173°E, with a central pressure of 936 mb. In a standard atmosphere, this is equivalent to a height of approximately 2,200 ft above sea level. The JAG ANAND battled 65-kt typhoon-force winds 180 mi to the southeast. The SETR wasn't enjoying a leisurely cruise, 300 mi to the east. with 55-kt winds and 40-ft waves. The JAPAN WALNUT, only 150 mi south, and the PHILIPPINE MAIL, 720 mi southwest, both had 50-kt gales.

The LOW continued to track northeastward,and,as it moved into the Bering Sea, ship reports were not as numerous. During the next 24 hr, the SUZUKAWA MARU was battered by 55-kt winds, 33-ft seas, and 50-ft swells, 350 mi southeast of the LOW. The JCHF, JDND, and the 5CWD all reported 50-kt winds south and southwest of the center. Many island and shore stations around the Bering Sea had winds over 35 kt.

By 0000 on the 14th, the 966-mb LOW had moved northward to 59°N, 179°W. The cold Bering Sea was slowly conquering the storm. It still had some fight left, though, as the SPERO bucked 40-kt westerly headwinds south of the Aleutian Island chain. North of the island chain, about 350 mi south of the LOW, the ZEKOREN MARU No. 2 was boosted along by 50-kt westerly winds, but the 15-ft seas and 33-ft swells were of no help whatsoever. Early on the 15th, the USCGC JARVIS ran aground at Dutch Harbor in high seas and winds. Emergency repairs were made, but later in the day her engineroom flooded. The Japanese ship, KOYO MARU No. 3, took the cutter in tow to Beaver Inlet at Sedanka Island.

Supertyphoon Ruby formed just east of the International Dateline. The hurricane became a typhoon on the 14th. It moved west-northwestward at about 12 kt. On the 16th she was located near 14.5°N, 171.5°E with a well-defined eye. Ruby intensified quickly and dissipated just as fast. Maximum winds reached 130 kt with gusts estimated at 170 kt on the 17th, near 16°N, 169°E. Thirty-six hours and 500 mi later, Ruby was a depression. By the 20th, she was unidentifiable.

Casualties--The Japanese yacht, MERMAID II, 2 days out of Tannowa Port on a round-the-world, nonstop solo voyage, lost all four masts in winds reported to be 54 kt about 60 mi south of Cape Shio on the 14th. The 65-ton Japanese trawler No. 25 KONKO MARU sank in stormy waters with winds of 40 kt, on the 21st, off Cape Sata. Nine of eleven crew members are missing. The 9,803-ton Monrovian bulk carrier EASTERN BUILDER had her no. 1 winch damaged by deck cargo which broke loose during heavy weather. The Chinese-registered TAI CHUNG (6,164 tons) dragged her anchor in heavy weather, at the Mutsuce Anchorage on the 27th.

SMOOTH LOG, DECEMBER 1972--Cyclone activity in the North Pacific was slightly higher than usual. The storm track out of Manchuria into the Bering Sea, was near normal, although nearer the western shore. The significant difference from climatic records was the primary track from south of Honshu. It is northeastward into the Aleutian Islands, normally, but this month it was almost due east between 35° and 40°N, to near 155°W, where cyclones either dissipated or turned northeastward toward the coast of British Columbia.

Climatologically, during December the Aleutian Low is elongated east-west with the main center of 1001 mb in the western part near 52°N, 162°E. A 1034-mb High is located over central Siberia and a 1021-mb narrow High extends from northern California southwestward toward the Hawaiian Islands. During December 1972, the pressures all across the North Pacific were generally higher than normal, but some of the pressure centers were displaced resulting in several large anomalies. The mean Aleutian Low averaged about 3 mb higher than normal with four separate centers. The one near the Kamchatka Peninsula was near its normal position, another was south of Dutch Harbor, and another was in the Gulf of Alaska. The most significant Low was near 40°N, 158°W. The Highs over Siberia and off the California coast were 2 or more mb higher than the normal, as was the pressure across the central North Pacific along 30°N.

There were two major negative anomalies. The most important and largest was 11 mb, centered near 37°N, 156°W. The other negative anomaly of 4 mb was about 250 mi southwest of Vancouver Island. In addition, there were two positive anomalies located near 45°N, 160°E and near 60°N, 170°W in the Bering Sea. There were several positive 3- to 5-mb anomaly centers south of 30°N.

No tropical storms occurred in the eastern North Pacific,and none have been detected later than November since satellite coverage began in 1966. Two typhoons, Sally and Therese, and one tropical storm, Violet, occurred during the month. Normally about one tropical storm a year is expected, and three out of four of these develop to typhoon strength.

The first storm of this month formed in central China and for the first days of its existence gave little indication of developing into anything. As the LOW passed up the Sea of Japan on the 1st, it split into two centers astride Hokkaido. The new LOW became the predominant one and,at 1200 on the 1st, was near 44°N, 145°E. To the south of the LOW, the KASHU, SHOZUI MARU, and WAKO MARU were buffeted by 40-kt gales. This LOW split again on the 2d, with the HAKONE MARU, ST. LAWRENCE MARU, and the TOCHIGI MARU to the south and west of the center on the receiving end of 50-kt gales. The ARCTIC TOKYO, 120 mi south of the center, fought 60-kt storm winds. She was following the path of the LOW and stayed with the strong winds until the 5th. Luckily, during that period, the winds gradually decreased as the LOW outdistanced the ship. The EREC, a Russian weather ship, also reported 50-kt winds. One crew woman was killed and 12 other crew members were missing as 18 fishing boats sank and 133 others were damaged off Bekkai, Hokkaido. Six houses were destroyed and 114 flooded as 20-ft waves swept low-lying sections. Two other fishing boats were missing near Etorofu, Kuril Islands,where winds of 58 kt were reported.

By the 4th, the LOW had reached 51°N, 170°E, at a pressure of 966 mb. The ORIENTAL JADE was boosted along her track with a 50-kt stern wind. A high-pressure area in the Gulf of Alaska was moving

very slowly to the southeast resulting in a tight pressure gradient ahead of the LOW. Many ships were experiencing gale winds of 35 to 40 kt. On the 5th, the KOTOKU MARU, near 52°N, 165°W, reported 45-kt gales while the storm had moved into the Bering Sea. By the 6th, the LOW had filled to 979-mb and moved ashore near Mys Olyutorskiy. The cold land area, plus a low-pressure area in the Arctic Sea, ended this storm's career.

The previously mentioned high-pressure area in the Gulf of Alaska retreated northward into the Yukon to join with an already existing HIGH to form a 1055-mb pressure dome. At this time, on the 5th, a 1011-mb LOW suddenly developed in a col area off Seattle. The VANCOUVER, 300 mi off Cape Flattery, reported 40-kt gales. Early on the 6th, the LOW, now at 997 mb, had moved southwest of Portland. Off the northern tip of Vancouver Island, the UNYO MARU was buffeted by 55-kt winds. The NNCR reported heavy continuous snow blown by a 45-kt gale. Winds up to 48 kt roared through Portland, Oreg., and gale warnings for 45 kt were posted along the coast with 60 kt in the mountains. The LOW, now down to 1000-mb pressure, passed onshore in southern Oregon at 0600 on the 6th. The WASHINGTON MAIL reported 45-kt gales and 32-ft seas with 32-ft swells about 300 mi out of Seattle. On the 7th, the LOW was well into Nevada, but gale-force winds remained off the coast as the AMERICAN LEGION and STEEL APPRENTICE could attest. The storm stalled in the Great Basin after leaving much welcomed moisture all along the west coast.

One of several storms that formed and dissipated in that area of large negative anomalies north of Hawaii had its beginning on the 4th near 29°N, 150°W. It wandered in the area, in a clockwise loop, at about 1000-mb pressure until the 7th, without affecting shipping. At that time, the MONTEREY and Ocean Station Vessel "N" reported 40- and 45-kt gales. "N" also reported 16-ft seas and 26-ft swells. Twenty-four hours later, the LUNA MAERSK had 40-kt gales in the same area. The LOW was now intensifying and, at 1200 on the 10th, the pressure had dropped to 988 mb. As the area of circulation expanded, more ships became involved. The following ships reported 35- to 50-kt winds with seas to 25-ft: the BELLNES, CHICAGO, KOREAN TRADER, MARCHEN, and the MARGARET CORD. Again the storm made a loop during the period of the 10th to the 12th, but this time counterclockwise. The JANEGA, sailing west along 35°N, reported 60-kt northwesterly winds at 165°W and 167°W, from 1200 on the 10th to 0000 on the 11th. On the 12th, as the LOW was near 32°N, 155°W, a ship, 180 mi to the south, was hit by 45-kt gales. Now, the LOW was filling and moving northeastward, as a wave on a frontal system approached from the west. By 0000 on the 14th, this new system had absorbed the old one and continued into the Gulf of Alaska.

Compared to most of the individual systems this month, this LOW had a long life. The lineage starts with a frontal system that came out of Manchuria and China on the 7th. The front moved eastward with a steady pace and, on the 10th, a wave formed near 36°N, 166°E. The possibility of its surviving seemed remote, as it was sandwiched between a high and a ridge. Survive it did, as it was well identified by ship reports. On the 12th, the ridge had retreated northward as the LOW had intensified to 1004 mb and had taken a southeasterly course toward the active cyclone area for this month, which was located between Alaska and the Hawaiian Islands. It was on the 14th that it absorbed the previously described system. By the 15th, the LOW was at 38.5°N, 145.0°W and the HAWAIIAN MONARCH, TERUKAWA MARU, and the USCGC WACHUSETT all reported 40-kt gales in the southern quadrant of the storm. The LOW picked up speed in its northeasterly movement. The BARON-FORBES, HAWAIIAN CITIZEN, and the WORLD PRESIDENT reported 40- to 50-kt winds along the front and south of the LOW. The WORLD PRESIDENT was being washed by heavy, continuous rain. The ROBERT BANKS, heading east toward Seattle, was rolled by 55-kt southeasterly winds.

At 1200 on the 16th, this LOW combined with a stationary 970-mb LOW just south of Valdez. The OREGON MAIL was proceeding toward Ocean Station Vessel "P" with 50-kt gales.

Between 0000 and 1200 on the 21st, a well-defined small 986-mb LOW developed near 45°N, 135°W, as a wave raced up the front in the area. The TAI SHOU, very near the center, suddenly found 50-kt winds off her bow. The LIECHTENSTEIN, moving southwestward, had been struggling with 45-kt gales for 3 days, now found 60-kt westerly winds after passing through a cold front on the 21st in the vicinity of 37°N, 147°W. The seas had picked up to 20 ft. The LOW raced toward the Olympic National Park on the 22d, and the HAWAIIAN, 350 mi southwest of Astoria, was rolled by a 45-kt crosswind. By 0000 on the 23d, the LOW was well into the State of Washington.

A cold front extended south, then southwest out of a LOW moving along the Aleutian Islands. Near 34°N, 149°E, on the 20th, a wave formed with 1003-mb pressure. Twenty-four hours later, the now 992-mb LOW had sped 1,000 mi to 40°N, 169°E. Along the way, several ships reported gale winds and others must have experienced them during nonsynoptic hours. Apparently caught up under or with the jet stream, the LOW continued its headlong plunge eastward to 43°N, 161°W, at 0000 on the 22d. The central pressure was now 980 mb. Along the way, the AMERICAN AQUARIUS and the ORE MERIDIAN encountered 45- and 40-kt gales, respectively. At this time, the LOW curved northeastward into the Gulf of Alaska and braked to a near halt. The pressure was now 952 mb, near 52°N, 151°W at 0000 on the 23d. Gale winds of up to 50 kt were being reported in all quadrants. These included the GOLDEN ARROW, MATSUBARA MARU, and the JAPAN AZALEA. In the next 24 hr, the DAISHOWA MARU and Ocean Station Vessel "P" were pounded by gales up to 50 kt. The TOWER BRIDGE, near 46.6°N, 146.7°W at 1800 on the 24th, was walloped by 63-kt winds. As the LOW moved slowly northward off Kodiak Island, another LOW moved in from the southwest and assimilated it in its circulation early on the 25th. The 12,723-ton carrier PACROVER, with 33 crew members, radioed it was sinking 750 mi south of Kodiak Island on the 24th. Search and rescue vessels and aircraft found no survivors, but did find an oil slick and overturned lifeboats. One report said the ship radioed it was sinking in 55-ft seas and 50-kt winds. A Coast Guard

aircraft reported 20-ft waves and 50-kt winds. This would have been south of the LOW, moving in from the southwest. The DAISHOWA MARU, near 48.9°N, 147.3°W at 1000 on the 25th, struggled with 65-kt winds and 39-ft seas. Twenty-four hours earlier, farther east, she had only 50-kt winds and 32-ft seas. Also on the 24th, a 48-ft crab boat was overturned three times by huge swells off the northern California coast. Four men aboard were rescued. The TOKUSHIMA MARU reported 60-kt southeasterly winds ahead of the front near Vancouver Island. South and east of the LOW, now near 55°N, 147°W, all reports were greater than 35 kt for a radius of 600 mi. By the 27th, only a trough remained in the area.

This weather system tracked from the South China Sea to the Gulf of Alaska. A low-pressure area, 1010-mb, moved out of China and, at 1200 on the 22d, was near 28°N, 125°E. Heavy rain was reported north of the warm front at that time. As the LOW gained strength and moved to the northeast up the coast of Japan, the SHOHUKU MARU was buffeted by 40-kt gales. ROSE CITY, at 33.4°N, 140°5°E, reported 47-kt winds. At 0600 on the 24th, the 998-mb LOW was off Tokyo Bay, while the front had raced hundreds of miles ahead. Over 5,000 homes were flooded east of Tokyo as the storm dropped over 8 in. of rain. Many rainfall records were broken. In the mountains west of Tokyo up to 16 in. of snow fell. The 6,516-ton Liberian freighter VINCEVERETT sprang a leak which flooded its engineroom.

In the next 48 hr, the system continued deepening and the winds picked up, especially in the southern half of the circulation. The EVER LIGHT, at 35°N, 154°E, about 350 mi southwest of the center, was bucking a 50-kt headwind and waves of 20 ft. Closer in, the KINKO MARU and the NANSHO MARU reported 40-kt gales. The JANEGA, headed back east now, was caught by this storm with 56-kt winds. Thirty-six hours later, she still had 55-kt winds and 36-ft seas.

By 0000 on the 27th, the LOW had arrived at 46°N, 177°W, with a pressure of 960 mb. The JDXW was sailing along with 50-kt winds and 30-ft swells off her stern, 12 hr earlier. At this time, the JUZAN MARU, 450 mi to the south, was riding out 55-kt storm winds and 33-ft swells from the stern. In addition, these vessels encountered 45-kt gales to the north, southwest, and southeast of the LOW center: the HARUNA MARU, NANSHO MARU, and the SHOKAI MARU (heavy snow). For the next 24 hr, the storm continued its northeasterly track south of the Aleutian Islands. Gale-force winds were reported in all directions as far as 600 mi from the center. At 1200 on the 28th, the CALIFORNIA, north of Atka Island, was rolled by a 45-kt crosswind with 16-ft seas and 26-ft swells quartering off the stern. To add to the misery, the temperature was -1°C with rain and snow showers. The wind speeds started dropping considerably as the central pressure increased from the minimum of 954 mb at 1200 on the 27th. A few reports of minimal gale-force winds continued to be received as the LOW moved toward Prince William Sound, which became its burial ground late on the 31st.

The 28th and 29th had several LOWS over the Japanese Islands. On the 1200 chart of the 29th, they had consolidated into one 992-mb LOW. The ELIZABETHPORT, 350 mi to the south, reported 45-kt gales. The LOW traveled northward and was just south of the Kamchatka Peninsula at 1200 on the 30th. At that time, the VAN WARRIOR, 200 mi south of the center, encountered 50-kt southerly winds which quickly shifted to the west. Six hours later, the ROBERT BANKS, north of the warm front and east of the occlusion near 47.6°N, 170.7°E, was again involved in 60-kt winds and 30-ft seas. Gale winds up to 50 kt were reported in all directions from the LOW. The LOW continued to move up the Kamchatka Peninsula, dropping to its lowest pressure of 944 mb at 0000 on the 31st near 55.7°N, 161.4°E. Island weather stations in the Kurils and Aleutians reported 50-kt winds, but 45-kt was the highest by a ship. On January 1, 1973, the LOW split into two centers which quickly filled. One center moved westward to disappear in the Sea of Okhotsk, and the other moved northeastward and had its demise in the Bering Strait.

Sally was detected as a tropical storm on the 1st, some 200 mi southeast of southern South Vietnam. She reached typhoon strength that same day, and moved west-northwestward into the Gulf of Siam. The Panamanian-registered BONWAY (1,387 tons) sank near 6.7°N, 106.2°E on the 2d. Six crewmembers are missing. The JAPAN ORCHID and the MADISON LLOYD both reported 35-kt gales well to the northeast of the storm. By the 3d, she was generating 75-kt winds. Sally was the first typhoon in the Gulf of Siam since accurate records started in 1945. The typhoon lost strength as she moved across the Gulf and was reduced to tropical storm strength on the 4th near the Isthmus of Kra (10°N). Here she crossed the Malay Peninsula and moved into the Andaman Sea. Sally was now considered a tropical cyclone of the Indian Ocean. On the 7th and 8th, she moved northward along the 95th meridian. Near the mouths of the Irrawady, Sally turned eastward and crossed the coast of Burma on the 10th.

Late season typhoons usually form south of 15°N and often cause trouble in the central and southern Philippines. Typhoon Therese was no exception. Therese was initially found on the 1st about 180 mi east of Koror, as a tropical depression. The next day, she moved across that Island as a tropical storm. Koror recorded a maximum wind speed of 43 kt on the 2d. Her track was a typical west-northwesterly one and the Philippines lay ahead. Therese became a typhoon off the coast of Mindanao on the 3d, and the MICHIJU MARU found 35-kt gales 500 mi to the north. It took her 1 day to make it across the Central Islands and, on the 4th, Therese, a tropical storm again, made it into the South China Sea. She stalled north of Palawan until the 6th, when once again she reached typhoon strength. Shipping seemed to give her a wide berth as the highest winds reported by ships were 30 kt 100 to 200 mi from her eye. The typhoon moved west-northwestward toward South Vietnam. Winds near the center reached 105 kt with gusts to 145 kt on the 7th. As Therese approached land, she began to weaken. On the 10th, the typhoon, generating 75-kt winds, moved across the South Vietnam coast south of Da Nang.

As Therese withered in South Vietnam, Violet bloomed briefly across the sea among the Marshall Islands. Violet was not a violent storm as judged by wind intensity; maximum winds reached just 45 kt on the

(continued on page 186)

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

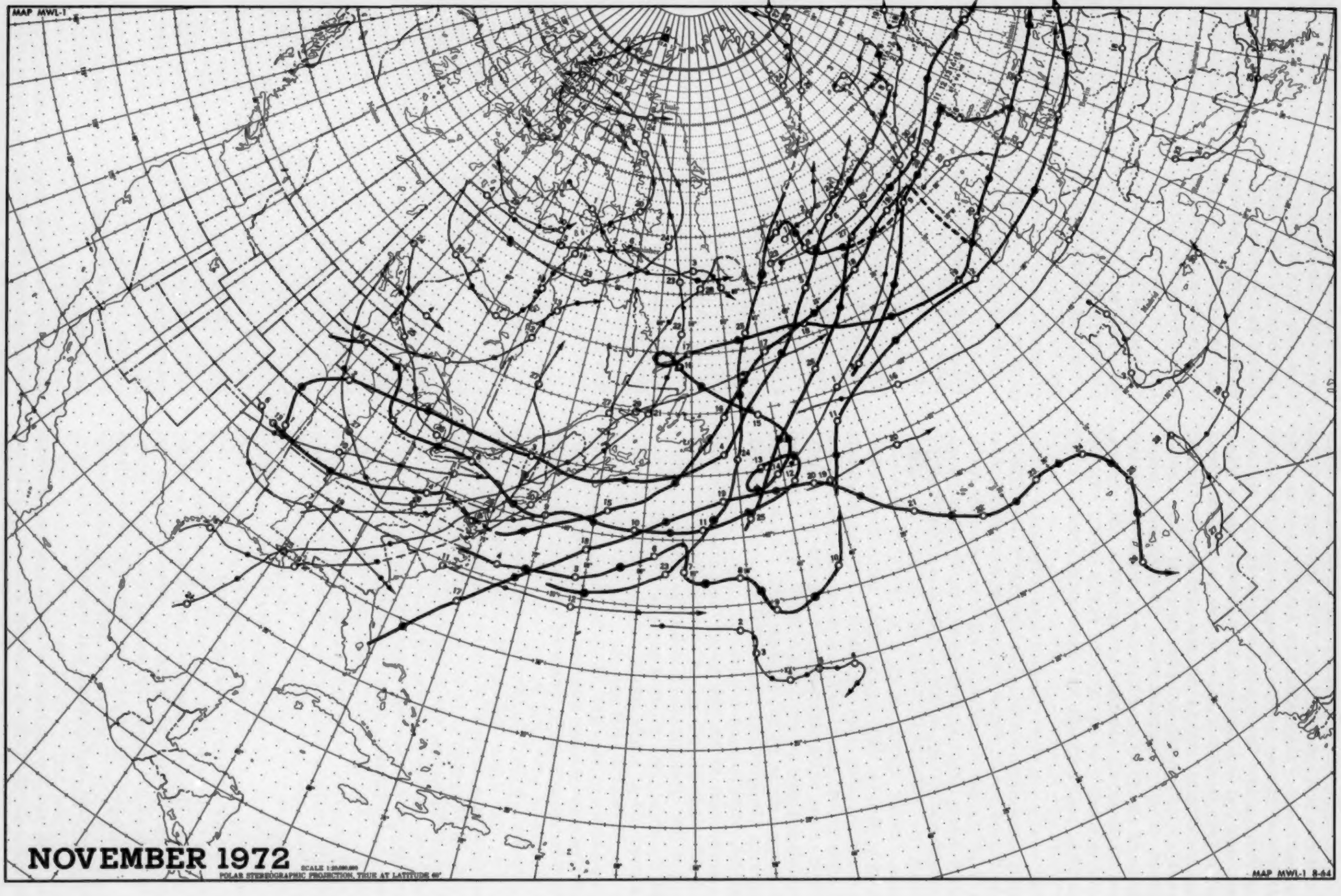


Figure 32. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

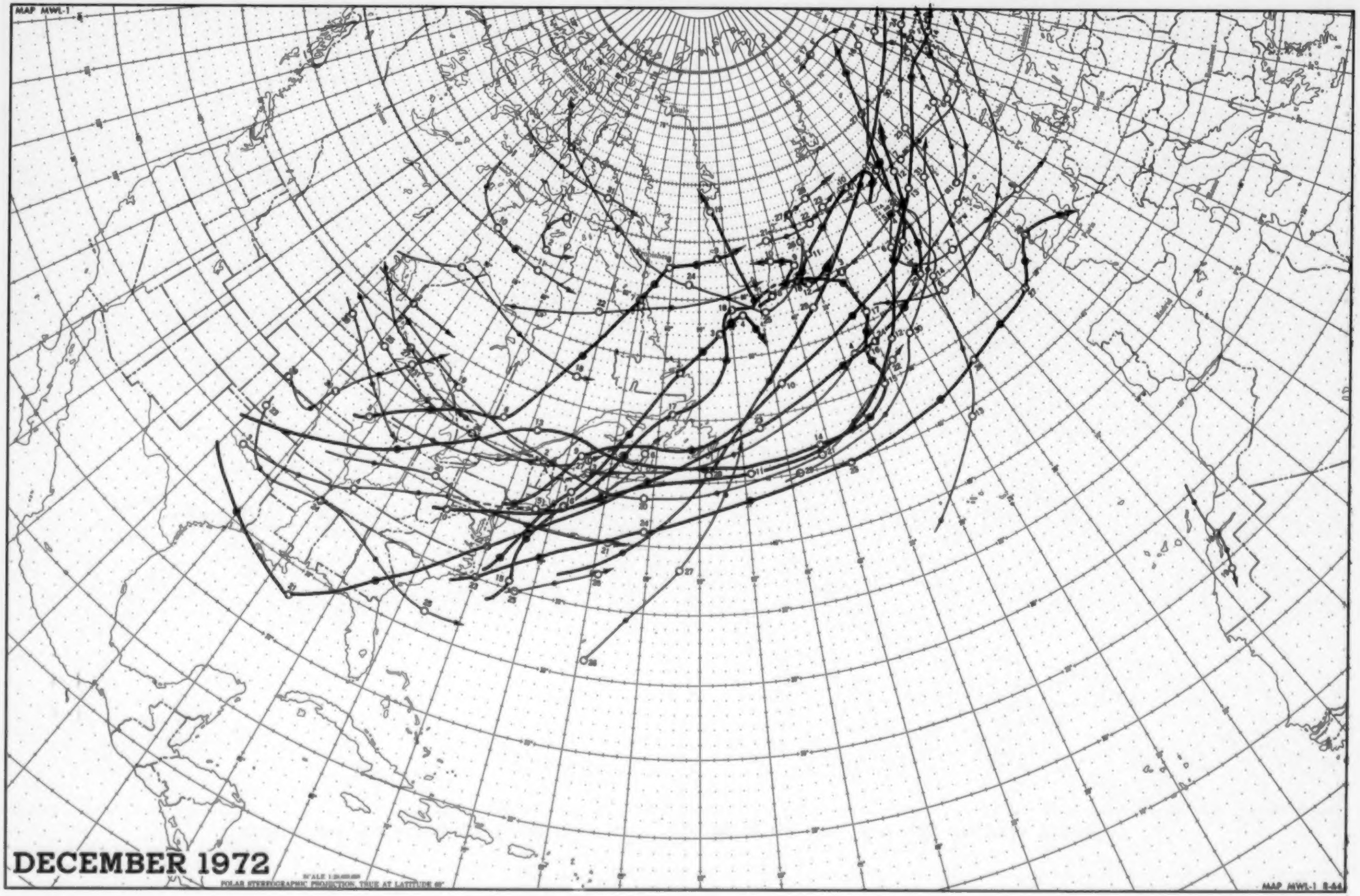


Figure 33. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

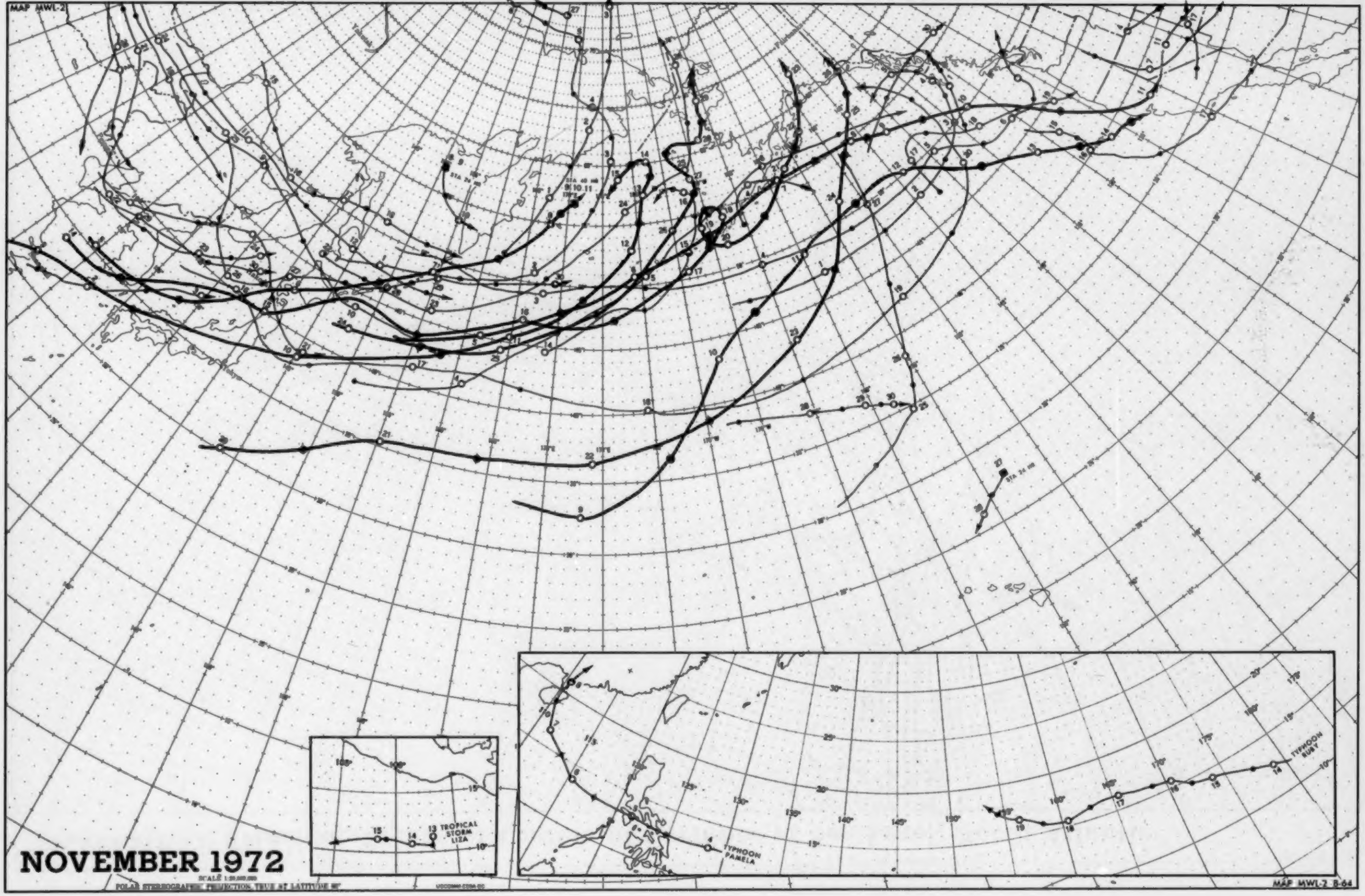


Figure 34. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Figure 34. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

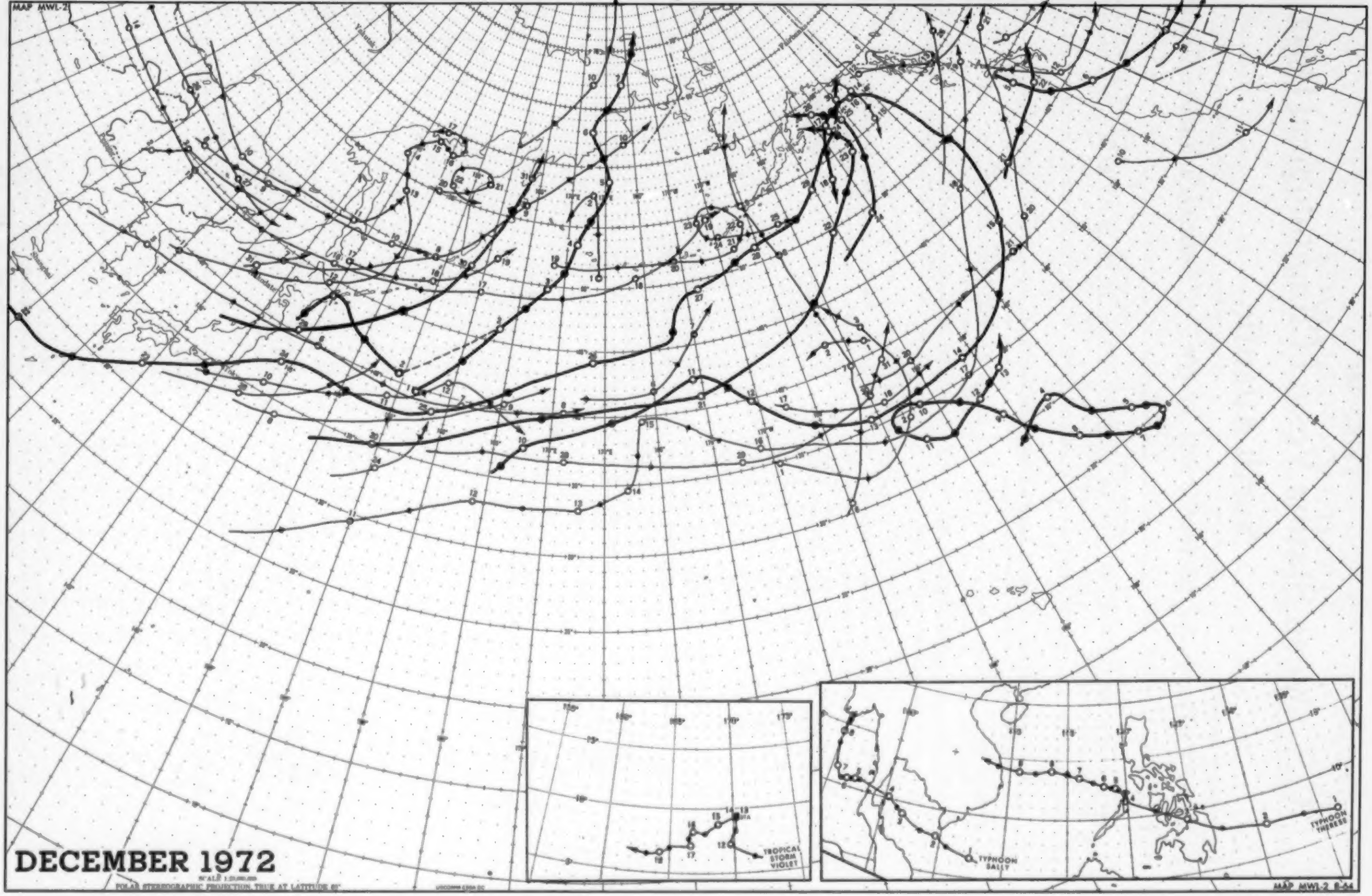


Figure 35. --Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 10

U.S. Ocean Station Vessel Climatological Data, North Atlantic

Ocean Weather Station 'BRAVO' 56°30'N 51°00'W **November and December, 1972**

MEANS AND EXTREMES

	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
MONTH	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
NOV	- 4.0	04 06	1.0	5.2	27 21	-12.0	04 04	- 3.6	4.5	28 00	- 2.2	12 15	3.4	5.0	13 03	- 7.8	04 06	- 2.5	3.1	12 15
DEC	-11.1	08 09	- 3.4	2.8	02 12	-15.4	14 18	- 6.9	1.8	07 18	1.1	*11 09	3.5	5.6	21 09	-14.8	08 18	- 6.9	- .2	07 21

	MEANS AND EXTREMES: PRESSURE (MB)					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD				LOW CLOUD				DAYS WITH SPECIFIED WEATHER										
MONTH	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
NOV	966.4	25 06	1008.7	1035.1	09 18	3.6	5.5	27.3	63.6	5.9	12.8	31.5	49.8	26	22	24	0	2	16	9	3	25	34.1	220
DEC	949.4	02 21	995.7	1022.9	22 09	2.4	13.7	30.6	53.2	5.6	24.2	28.2	41.9	30	27	29	0	6	23	7	0	31	39.5	248

** VV-90-03 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

NOV WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	2.7	3.8	1.7	1.5	.0	9.7	19.3
NE	.0	1.4	3.5	1.5	1.6	.0	8.0	20.6
E	.0	2.0	3.0	2.2	1.4	5.5	14.0	33.0
SE	.0	1.4	.5	.1	.8	.0	2.7	18.2
S	.0	.3	.9	2.3	3.5	1.0	8.1	34.6
SW	.0	.1	1.5	4.0	.5	3.0	9.0	35.2
W	.0	.9	4.8	9.0	3.3	1.0	19.0	27.5
NW	.0	4.8	10.8	3.2	8.4	.0	29.2	23.5
CALM	.5	.0	.0	.0	.0	.0	.5	.0
TOTAL	.5	13.6	28.6	25.9	20.9	10.5	100.0	26.7

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
220	220	70	*28 0555	6.5	289	

DEC WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	1.0	4.6	1.9	.8	.4	8.8	21.3
NE	.0	.4	1.0	1.0	.4	.4	3.2	24.0
E	.4	.4	1.5	.6	.0	.0	2.9	14.0
SE	.0	.4	1.2	.5	1.1	.8	4.0	32.3
S	.0	.4	1.2	1.6	.9	.0	4.1	25.1
SW	.0	1.3	1.9	4.4	2.2	.0	9.9	23.4
W	.0	.6	7.6	16.0	10.3	.7	35.2	28.5
NW	.0	.7	8.4	15.4	6.0	1.3	31.9	27.4
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.4	5.2	27.4	41.5	21.8	3.6	100.0	26.4

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
248	120	60	02 0800	17.1	286	

Wave

NOV WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	4.5	1.6	1.0	.3	.0	.0	.0	7.5
NE	.7	4.1	2.3	1.1	2.7	.0	.0	.0	10.9
E	1.1	2.8	2.3	3.2	2.7	3.2	2.7	.0	18.1
SE	.9	.0	.1	.0	.7	.0	.0	.0	1.7
S	.0	1.6	1.9	1.1	3.9	.3	.0	.0	8.9
SW	.0	.7	.9	.8	2.5	2.0	.7	.0	7.6
W	.0	1.7	2.4	3.5	3.9	3.1	.7	.0	15.2
NW	.0	5.5	8.5	3.1	4.2	4.1	.0	.0	27.4
IND	.5	.5	1.8	.0	.0	.0	.0	.0	2.7
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	3.2	21.4	21.8	15.9	20.9	12.7	4.1	.0	100.0

NUMBER OF OBS 220 IND=INDETERMINATE

DEC WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	1.4	2.4	2.6	.4	.8	.0	.0	8.1
NE	.0	1.0	.0	.5	.5	.0	.0	.0	2.0
E	.0	.0	.0	.0	.7	.0	.0	.0	.7
SE	.0	.4	.1	1.0	2.4	.4	.0	.0	4.3
S	.0	.0	2.9	1.0	.4	.0	.0	.0	4.3
SW	.0	2.2	3.9	2.8	3.5	.5	.0	.0	13.0
W	.0	2.9	7.0	10.0	5.3	6.8	1.2	.0	33.2
NW	.0	2.5	9.5	11.1	7.3	2.4	.4	.0	33.2
IND	.0	.0	.4	.4	.4	.0	.0	.0	1.2
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	10.5	26.6	29.4	21.0	10.9	1.6	.0	100.0

NUMBER OF OBS 248 IND=INDETERMINATE

NOV WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	2.7	12.7	1.8	.5	.0	.0	.0	.0	17.7
6-7	.0	4.1	8.6	8.6	4.5	.9	.0	.0	26.8
8-9	.0	4.1	7.7	6.8	14.1	10.0	1.4	.0	44.1
10-11	.0	.0	1.8	.0	2.3	1.8	1.8	.0	7.7
12-13	.0	.0	.0	.0	.0	.0	.9	.0	.9
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.5	.5	1.8	.0	.0	.0	.0	.0	2.7
TOTAL	3.2	21.4	21.8	15.9	20.9	12.7	4.1	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR	IND=INDETERMINATE (DIR IN DEGREES)
220	9.5	12	090	SEA	17 00	

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

DEC WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	9.3	7.3	.0	.0	.0	.0	.0	16.5
6-7	.0	1.2	19.0	20.6	4.4	.0	.0	.0	45.2
8-9	.0	.0	.0	8.1	12.9	.0	.0	.0	21.0
10-11	.0	.0	.0	.4	2.8	8.9	.4	.0	12.5
12-13	.0	.0	.0	.0	.4	2.0	1.2	.0	3.6
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.4	.4	.4	.0	.0	.0	1.2
TOTAL	.0	10.5	26.6	29.4	21.0	10.9	1.6	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR	IND=INDETERMINATE (DIR IN DEGREES)
248	8.5	15	300	SEA	31 21	

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 11
CLIMATOLOGICAL DATA

Ocean Weather Station 'CHARLIE' 52°45'N 35°30'W November and December, 1972

MEANS AND EXTREMES

	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
MONTH	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
NOV	2.9	30 21	6.9	10.7	*24 21	- 4.9	24 03	2.6	10.0	25 03	7.8	*30 18	8.7	10.0	*18 09	- 6.0	01 15	- 1.8	2.6	26 12
DEC	.2	27 00	4.2	9.4	28 21	-11.4	02 03	- .2	8.5	28 21	5.7	26 03	7.7	10.6	*13 15	- 8.6	13 06	- 3.5	2.2	28 21

	MEANS AND EXTREMES					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS)								DAYS WITH SPECIFIED WEATHER										
	PRESSURE (MB)					TOTAL CLOUD				LOW CLOUD					RAIN OR			VSBY <1KM	WIND (KTS)					
MONTH	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN	DRZL	SNOW	TSTM	**	≥34	≥48	≥64	COMP OB DAYS	HOURS WITH PCPN	NO OF OBS
NOV	983.0	30 15	1009.7	1023.4	03 00	2.8	7.4	44.4	45.4	11.1	33.3	38.9	16.7	12	11	1	0	1	12	2	1	12	20.4	108
DEC	950.2	15 18	995.2	1030.6	22 21	.7	19.7	31.4	48.2	3.6	28.5	29.9	38.0	17	17	7	0	1	18	7	2	16	30.7	137

** VV-90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

NOV WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
	WIND SPEED (KNOTS)							
N	.0	2.5	6.7	6.5	2.3	.0	18.1	22.3
NE	.0	.0	.2	1.9	1.2	.0	3.2	30.7
E	.0	.0	.0	.0	.0	.0	.0	.0
SE	.2	.0	2.8	6.9	2.5	.0	12.5	28.2
S	.7	.0	7.6	6.0	6.7	.0	21.1	26.1
SW	.0	2.8	3.7	7.4	1.9	.9	16.7	23.8
W	.0	.7	5.3	4.4	5.3	.0	15.7	27.5
NW	.0	2.3	4.2	4.9	1.4	.0	12.7	23.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.9	8.3	30.6	38.0	21.3	.9	100.0	25.3

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
108	280	65	26 1600	7.3	239	

DEC WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
	WIND SPEED (KNOTS)							
N	.0	.0	.5	1.5	.5	.0	2.6	25.8
NE	.0	.7	1.6	1.5	2.4	.9	7.1	31.6
E	.0	.0	1.3	.7	2.2	1.3	5.5	34.3
SE	.0	.0	1.8	.4	.0	1.3	3.6	30.6
S	.0	.0	5.1	2.4	.7	.0	8.2	21.1
SW	.0	1.1	7.1	6.9	4.4	1.5	21.0	27.4
W	.0	1.8	12.4	12.4	.0	.0	26.6	20.4
NW	.0	1.5	3.6	7.8	8.0	4.4	25.4	33.3
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	5.1	33.6	33.6	18.2	9.5	100.0	27.3

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
137	330	74	24 0540	11.5	282	

Wave

NOV WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
	WAVE HEIGHT (METERS)								
N	.0	.0	7.4	2.8	4.4	1.4	.0	.0	16.0
NE	.0	3.7	1.4	1.2	1.2	.2	.0	.0	7.6
E	.0	.0	.0	.0	.0	.0	.0	.0	.0
SE	.0	.0	1.9	5.1	2.5	.0	.0	.0	9.5
S	.0	1.9	1.9	5.1	10.4	.0	.0	.0	19.2
SW	.0	.0	1.9	1.4	8.3	.2	.0	.0	11.8
W	.0	.0	4.9	1.4	3.7	4.2	.0	.0	14.1
NW	.0	.0	9.3	2.5	2.8	1.6	.0	.0	16.2
IND	.0	.0	5.6	.0	.0	.0	.0	.0	5.6
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	5.6	34.3	19.4	33.3	7.4	.0	.0	100.0

NUMBER OF OBS 108 IND=INDETERMINATE

DEC WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
	WAVE HEIGHT (METERS)								
N	.0	.0	.0	.0	.7	.0	.0	.0	.7
NE	.0	.0	.0	.0	3.1	5.1	.0	.0	8.2
E	.0	.0	.0	.7	4.2	.0	.0	.0	4.9
SE	.0	.7	.9	.9	.7	.7	.0	.0	4.0
S	.5	.7	1.8	1.3	1.3	.5	.0	.0	6.2
SW	.2	.2	4.0	.2	8.2	3.3	.0	.0	16.1
W	.0	3.3	12.6	5.8	.0	.5	.0	.0	22.4
NW	.0	.7	7.7	7.8	5.1	2.2	3.6	1.5	28.6
IND	.0	.0	1.5	2.2	5.1	.0	.0	.0	8.8
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.7	5.8	28.5	19.0	28.5	12.4	3.6	1.5	100.0

NUMBER OF OBS 137 IND=INDETERMINATE

NOV WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
	WAVE HEIGHT (METERS)								
<6	.0	1.9	13.9	2.8	.0	.0	.0	.0	18.5
6-7	.0	2.8	11.1	14.8	6.5	.9	.0	.0	36.1
8-9	.0	.9	1.9	.9	24.1	6.5	.0	.0	34.3
10-11	.0	.0	1.9	.9	2.8	.0	.0	.0	5.6
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	5.6	.0	.0	.0	.0	.0	5.6
TOTAL	.0	5.6	34.3	19.4	33.3	7.4	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
108	7.0	8	270	SEA	27 00

IND=INDETERMINATE (DIR IN DEGREES)

DEC WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
	WAVE HEIGHT (METERS)								
<6	.7	2.9	.7	.0	.0	.0	.0	.0	4.4
6-7	.0	1.5	20.4	8.0	1.5	.0	.0	.0	31.4
8-9	.0	1.5	5.8	8.8	18.2	.0	.0	.0	34.3
10-11	.0	.0	.0	.0	2.9	9.5	.0	.0	12.4
12-13	.0	.0	.0	.0	.7	2.9	3.6	.0	7.3
>13	.0	.0	.0	.0	.0	.0	.0	1.5	1.5
IND	.0	.0	1.5	2.2	5.1	.0	.0	.0	8.8
TOTAL	.7	5.8	28.5	19.0	28.5	12.4	3.6	1.5	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
137	10.0	14	320	SEA	24 09

IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

Table 12

CLIMATOLOGICAL DATA

Ocean Weather Station 'DELTA' 44°00'N 41°00'W — November and December, 1972

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
NOV	8.4	27 03	15.0	19.4	16 06	1.0	27 00	11.6	17.6	*09 03	15.3	*30 21	16.7	19.1	16 09	- 7.5	27 00	- 1.6	2.9	28 06
DEC	- .1	31 21	9.2	17.1	02 12	- 5.4	31 12	4.6	15.9	02 12	8.0	21 03	14.6	16.7	12 21	-15.0	31 21	- 5.4	2.3	11 21

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
NOV	990.8	12 15	1012.1	1040.3	27 12	6.1	11.7	29.9	52.4	20.3	26.4	31.6	21.6	26	26	0	0	3	14	1	0	27	21.2	231
DEC	978.8	14 12	1016.9	1035.0	07 12	9.2	9.2	39.7	41.8	14.9	22.7	48.2	14.2	16	15	5	0	2	12	7	3	15	35.5	141

** VV=90-93 AND/OR W=4   COMP OB DAYS=COMPLETE OB DAYS

Wind

NOV — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.0	2.9	3.2	.4	.0	6.6	22.0
NE	.0	.6	4.0	3.2	.4	.0	8.3	20.9
E	.0	1.1	6.6	3.5	.8	.0	11.9	19.5
SE	.0	1.0	6.5	2.8	2.4	.0	12.7	21.4
S	.0	1.2	7.6	6.7	4.1	.0	19.6	23.6
SW	.0	.0	5.4	8.5	.1	.0	14.1	23.1
W	.0	1.9	4.0	6.7	4.4	.0	17.1	24.7
NW	.0	1.9	2.8	3.4	.3	.0	8.4	19.2
CALM	1.3	.0	.0	.0	.0	.0	1.3	.0
TOTAL	1.3	7.8	39.8	38.1	13.0	.0	100.0	22.1

NUMBER OF OBS 231 — MAX WIND: DIR 030, SPEED 48, DA HR 20 1900 — VECTOR SPEED 5.3 — MEAN DIR 204 (DIR IN DEGREES)

DEC — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	3.2	2.5	.5	.5	.0	6.7	15.0
NE	.0	.0	1.6	.0	.0	.0	1.6	16.8
E	.0	.0	.0	.7	.0	.0	.7	27.0
SE	.7	1.4	1.8	3.4	.0	.0	7.3	19.2
S	.0	.7	1.1	4.3	1.8	.0	7.8	28.7
SW	.0	.0	2.5	7.4	.5	1.2	11.7	28.4
W	.0	2.1	9.0	6.4	7.4	5.3	30.3	32.3
NW	.0	2.5	10.6	9.9	7.4	2.7	33.2	27.4
CALM	.7	.0	.0	.0	.0	.0	.7	.0
TOTAL	1.4	9.9	29.1	32.6	17.7	9.2	100.0	27.4

NUMBER OF OBS 141 — MAX WIND: DIR 290, SPEED 85, DA HR 14 1600 — VECTOR SPEED 17.7 — MEAN DIR 277 (DIR IN DEGREES)

Wave

NOV — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	2.6	6.9	.0	.0	.4	.0	.0	10.0
NE	.0	.0	3.1	4.9	1.3	.0	.0	.0	9.3
E	.0	.0	.6	.8	.4	.0	.0	.0	1.8
SE	.0	.0	.5	1.4	1.9	.0	.0	.0	3.9
S	.0	.0	8.8	6.4	5.6	.0	.0	.0	20.8
SW	.0	.4	3.2	4.7	5.0	.9	.0	.0	14.2
W	.0	.0	5.1	4.9	10.2	1.2	.0	.0	21.3
NW	.0	.0	1.1	.4	4.1	.1	.0	.0	5.7
IND	.0	1.3	3.5	6.5	1.7	.0	.0	.0	13.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	4.3	32.9	29.9	30.3	2.6	.0	.0	100.0

NUMBER OF OBS 231   IND=INDETERMINATE

DEC — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.0	1.4	.5	.7	.0	.0	.0	2.7
NE	.0	.0	.0	.0	.0	.0	.0	.0	.0
E	.0	.0	.0	.0	.0	.0	.0	.0	.0
SE	.0	.0	1.6	1.4	.0	.0	.0	.0	3.0
S	.0	.0	.5	3.9	1.1	.0	.0	.0	5.5
SW	.0	.0	6.0	3.4	1.2	1.1	.0	.0	11.7
W	.0	.7	8.0	5.9	5.1	8.3	.0	3.0	31.0
NW	.0	.0	5.1	21.8	8.9	6.9	.0	.5	43.3
IND	.0	.0	.7	2.1	.0	.0	.0	.0	2.8
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	.7	23.4	39.0	17.0	16.3	.0	3.5	100.0

NUMBER OF OBS 141   IND=INDETERMINATE

NOV — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	.0	.9	.0	.0	.0	.0	.0	.9
6-7	.0	.0	12.6	3.9	1.7	.0	.0	.0	18.2
8-9	.0	3.0	16.0	17.3	23.8	.9	.0	.0	61.0
10-11	.0	.0	.0	1.7	3.0	1.7	.0	.0	6.5
12-13	.0	.0	.0	.4	.0	.0	.0	.0	.4
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	1.3	3.5	6.5	1.7	.0	.0	.0	13.0
TOTAL	.0	4.3	32.9	29.9	30.3	2.6	.0	.0	100.0

NUMBER OF OBS 231 — MAX WAVE HEIGHT: HGT 7.5, PER 11, DIR 230, TYPE SWL, DA HR 20 15 — IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

DEC — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	.0	2.8	.0	.0	.0	.0	.0	2.8
6-7	.0	.7	5.0	9.2	2.1	.0	.0	.0	17.0
8-9	.0	.0	14.2	17.7	11.3	7.1	.0	.7	51.1
10-11	.0	.0	.0	6.4	3.5	7.8	.0	.7	18.4
12-13	.0	.0	.7	3.5	.0	1.4	.0	2.1	7.8
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.7	2.1	.0	.0	.0	.0	2.8
TOTAL	.0	.7	23.4	39.0	17.0	16.3	.0	3.5	100.0

NUMBER OF OBS 141 — MAX WAVE HEIGHT: HGT 16.5, PER 12, DIR 290, TYPE SEA, DA HR 14 18 — IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 13
CLIMATOLOGICAL DATA

Ocean Weather Station 'ÉCHO' 35°00'N 48°00'W — November and December, 1972

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
NOV	18.1	25 09	20.2	23.0	30 15	10.5	27 03	14.6	21.3	23 18	21.1	*25 06	22.0	22.8	*24 03	- 4.1	25 09	- 1.8	1.3	30 15
DEC	14.2	31 15	19.5	22.0	*11 15	7.4	14 00	16.2	20.0	28 18	19.2	*26 09	21.2	22.8	01 15	- 6.0	13 21	- 1.7	1.5	28 18

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
NOV	1003.2	18	1024.1	1034.2	29 00	8.6	25.9	46.6	19.0	15.5	41.4	36.2	6.9	5	5	0	0	0	2	0	0	7	5.2	58
DEC	1012.3	27 21	1023.5	1031.6	31 15	14.4	22.8	33.7	29.2	29.2	32.2	25.2	13.4	17	17	1	0	0	4	0	0	23	16.9	202

** VV-90-93 AND/OR W=4 COMP OB DAYS-COMPLETE OB DAYS

Wind

NOV WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	3.4	4.7	.0	.0	.0	8.2	11.4
NE	.0	1.7	4.3	.0	.0	.0	6.0	11.1
E	.0	8.2	22.4	.0	.0	.0	30.6	13.8
SE	.0	4.7	11.2	.0	.0	.0	15.9	14.3
S	.0	4.3	.0	.0	.0	.0	4.3	8.3
SW	.0	.0	.0	7.8	.0	.0	7.8	30.2
W	.0	5.2	3.0	4.3	.0	.0	12.5	16.0
NW	.0	1.7	11.2	.0	.0	.0	12.9	15.5
CALM	1.7	.0	.0	.0	.0	.0	1.7	.0
TOTAL	1.7	29.3	56.9	12.1	.0	.0	100.0	14.9

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	DA HR	VECTOR SPEED	MEAN DIR
58	280	36	23 2200	1.3	107

(DIR IN DEGREES)

DEC WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.0	4.2	4.1	.0	.0	8.3	19.7
NE	.0	1.5	.6	1.9	.0	.0	4.0	18.9
E	.0	2.5	3.3	5.2	.5	.0	11.5	20.2
SE	.0	2.1	4.0	.0	.0	.0	6.1	12.3
S	.0	5.1	4.3	4.0	.5	.0	13.9	15.9
SW	.0	5.2	13.2	7.4	.0	.0	25.9	16.3
W	.0	4.2	7.9	4.8	1.5	.0	18.4	18.4
NW	.0	2.7	3.0	4.3	.5	.0	10.5	19.5
CALM	1.5	.0	.0	.0	.0	.0	1.5	.0
TOTAL	1.5	23.3	40.6	31.7	3.0	.0	100.0	17.5

NUMBER OF OBS	MAX WIND DIR	MAX WIND SPEED	DA HR	VECTOR SPEED	MEAN DIR
202	270	42	14 1500	5.2	290

(DIR IN DEGREES)

Wave

NOV WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.0	.0	.0	.0	.0	.0	.0	.0
NE	.0	.0	.0	.0	.0	.0	.0	.0	.0
E	.0	16.8	8.2	.0	.0	.0	.0	.0	25.0
SE	.0	19.4	6.0	.0	.0	.0	.0	.0	25.4
S	.0	.0	1.3	.0	.0	.0	.0	.0	1.3
SW	.0	.0	7.8	3.0	.0	.0	.0	.0	10.8
W	.0	.0	23.3	12.5	.0	.0	.0	.0	35.8
NW	.0	.0	1.7	.0	.0	.0	.0	.0	1.7
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	36.2	48.3	15.5	.0	.0	.0	.0	100.0

NUMBER OF OBS 58 IND-INDETERMINATE

DEC WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.0	2.8	1.2	.5	.0	.0	.0	4.6
NE	.0	1.5	1.0	.4	.1	.0	.0	.0	3.0
E	.0	10.4	2.6	6.1	.4	.0	.0	.0	19.4
SE	.0	5.0	.0	.0	.0	.0	.0	.0	5.0
S	.5	4.7	1.5	.0	.0	.0	.0	.0	6.7
SW	.0	14.1	5.2	.0	.0	.0	.0	.0	19.3
W	.0	8.2	8.9	1.5	.5	1.0	.0	.0	20.0
NW	.0	3.2	5.7	3.7	1.0	.0	.0	.0	13.6
IND	.0	4.0	4.5	.0	.0	.0	.0	.0	8.4
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.5	51.0	32.2	12.9	2.5	1.0	.0	.0	100.0

NUMBER OF OBS 202 IND-INDETERMINATE

NOV WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	15.5	31.0	.0	.0	.0	.0	.0	46.6
6-7	.0	20.7	17.2	15.5	.0	.0	.0	.0	53.4
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	36.2	48.3	15.5	.0	.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
58	3.5	7	250	SEA	24 06

IND-INDETERMINATE (DIR IN DEGREES)

DEC WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.5	39.6	9.4	.0	.0	.0	.0	.0	49.5
6-7	.0	5.9	18.3	12.9	1.0	.0	.0	.0	38.1
8-9	.0	1.5	.0	.0	1.5	1.0	.0	.0	4.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	4.0	4.5	.0	.0	.0	.0	.0	8.4
TOTAL	.5	51.0	32.2	12.9	2.5	1.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
202	6.0	8	270	SEA	14 15

IND-INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

Table 14
CLIMATOLOGICAL DATA

Ocean Weather Station 'HOTEL' 38°00'N 71°00'W November and December, 1972

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR
NOV	6.1	23 21	14.8	23.9	03 12	- .7	23 15	9.8	21.0	26 21
DEC	2.5	17 09	15.1	23.0	*10 18	- 1.8	18 06	10.5	20.9	10 21

MONTH	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
NOV	12.3	22 21	19.5	25.4	03 12	-14.3	24 03	- 4.7	5.1	20 15
DEC	14.0	30 03	20.8	25.5	13 06	-20.3	*17 15	- 5.8	4.2	22 21

MONTH	MEANS AND EXTREMES: PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR
NOV	994.0	26 15	1015.9	1029.4	07 03
DEC	998.4	16 06	1018.5	1035.1	*08 15

MONTH	PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC
NOV	7.5	14.2	26.3	52.1	15.0	34.2	26.7	24.2
DEC	13.3	8.1	29.8	48.8	27.4	30.2	30.6	11.7

MONTH	DAYS WITH SPECIFIED WEATHER: PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
NOV	24	24	0	0	0	16	6	1	30	17.1	240
DEC	22	22	2	0	2	15	4	0	31	20.2	248

** VV=90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

NOV WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

WIND SPEED (KNOTS)

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	3.6	7.2	6.0	1.3	.0	18.1	20.6
NE	.0	5.2	8.3	2.5	1.0	.8	17.9	17.4
E	.4	2.2	5.4	2.7	1.0	.0	11.8	17.9
SE	.0	.9	1.9	.9	.9	.1	4.8	21.2
S	.0	.4	1.5	2.3	3.3	.7	8.2	31.2
SW	.0	.1	2.3	5.1	1.6	.0	9.1	27.2
W	.0	2.2	2.9	2.4	4.5	.0	12.0	24.8
NW	.0	1.6	4.7	10.1	.9	.0	17.3	22.7
CALM	.8	.0	.0	.0	.0	.0	.8	.0
TOTAL	1.3	16.3	34.2	32.1	14.6	1.7	100.0	22.0

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR
240	030	66	18 0036	4.9	328

(DIR IN DEGREES)

DEC WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

WIND SPEED (KNOTS)

DIR	<4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	1.2	5.5	1.8	.4	.0	9.0	17.8
NE	.4	2.2	3.0	3.3	.0	.0	9.0	16.8
E	.0	3.4	6.3	2.0	.7	.0	12.4	16.2
SE	.0	1.5	2.0	.4	.5	.0	4.4	17.2
S	.0	1.7	3.9	4.1	2.1	.0	11.9	22.8
SW	.0	1.3	1.9	6.9	1.4	.0	11.5	25.4
W	.0	1.9	6.6	8.4	6.8	.7	24.3	27.3
NW	.0	.8	5.4	5.7	3.0	1.3	16.3	26.3
CALM	1.2	.0	.0	.0	.0	.0	1.2	.0
TOTAL	1.6	14.1	34.7	32.7	14.9	2.0	100.0	22.5

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR
248	300	55	17 1300	8.2	276

(DIR IN DEGREES)

Wave

NOV WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

WAVE HEIGHT (METERS)

DIR	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.4	4.6	7.7	3.8	1.6	.7	.0	.0	18.8
NE	.0	6.4	10.5	3.3	2.6	1.3	.0	.0	24.1
E	.0	3.2	3.9	1.9	.0	.0	.0	.0	9.0
SE	.4	.4	.5	.4	.5	.0	.0	.0	2.3
S	.0	.8	2.0	4.9	4.8	.6	.0	.0	13.1
SW	.1	.8	2.6	2.7	2.8	1.0	.0	.0	10.1
W	.3	2.1	1.5	2.0	2.3	1.1	.0	.0	9.3
NW	.0	1.3	3.9	2.3	2.1	1.3	.0	.0	10.9
IND	.0	2.5	.0	.0	.0	.0	.0	.0	2.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.3	22.1	32.5	21.3	16.7	6.3	.0	.0	100.0

NUMBER OF OBS 240 IND=INDETERMINATE

DEC WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

WAVE HEIGHT (METERS)

DIR	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	2.7	3.3	.8	.7	.0	.0	.0	7.6
NE	.4	4.7	5.8	1.2	.4	.0	.0	.0	12.6
E	.4	3.5	2.0	.8	.3	.0	.0	.0	7.1
SE	.3	1.5	.1	.0	.9	.0	.0	.0	3.0
S	1.1	3.9	6.0	1.2	1.4	.0	.0	.0	13.7
SW	.0	2.1	4.5	4.4	2.2	.0	.0	.0	13.3
W	.0	3.0	5.7	4.8	6.4	1.8	.3	.0	22.1
NW	.0	3.0	4.6	4.4	2.2	.2	2.1	.0	16.6
IND	.0	3.6	.4	.0	.0	.0	.0	.0	4.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.4	28.2	32.7	17.7	14.5	2.0	2.4	.0	100.0

NUMBER OF OBS 248 IND=INDETERMINATE

NOV WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

WAVE HEIGHT (METERS)

PERIOD IN SECONDS	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	1.3	9.2	11.3	2.5	.0	.0	.0	.0	24.2
6-7	.0	6.7	13.3	14.6	5.4	.0	.0	.0	40.0
8-9	.0	2.9	5.4	4.2	9.6	2.5	.0	.0	24.6
10-11	.0	.8	2.5	.0	1.7	2.9	.0	.0	7.9
12-13	.0	.0	.0	.0	.0	.8	.0	.0	.8
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	2.5	.0	.0	.0	.0	.0	.0	2.5
TOTAL	1.3	22.1	32.5	21.3	16.7	6.3	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
240	7.0	11	290	SEA	09 18

IND=INDETERMINATE (DIR IN DEGREES)

DEC WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

WAVE HEIGHT (METERS)

PERIOD IN SECONDS	<1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	2.4	21.4	16.1	2.0	.0	.0	.0	.0	41.9
6-7	.0	3.2	16.1	15.3	9.7	.0	.0	.0	44.4
8-9	.0	.0	.0	.4	4.0	2.0	2.4	.0	8.9
10-11	.0	.0	.0	.0	.8	.0	.0	.0	.8
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	3.6	.4	.0	.0	.0	.0	.0	4.0
TOTAL	2.4	28.2	32.7	17.7	14.5	2.0	2.4	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR
248	9.0	8	310	SEA	17 21

IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

Table 15
Selected Gale Observations, North Atlantic
November and December 1972

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C: Air	Temperature °C: Sea	Sea Waves*: Period sec	Sea Waves*: Height ft	Swell Waves: Dir. 10°	Swell Waves: Period sec	Swell Waves: Height ft
NORTH ATLANTIC OCEAN		NOV.															
MV ROLAND	SWEDISH	1	42.5 N	47.8 W	00	02	45	1 NM	65	1004.5	16.2	16.0	6	16.5			
USCGC MORGENTHAU	AMERICAN	5	57.0 N	32.0 W	12	22	M 67	1 NM	80	977.8	6.9	8.5	11	21			
USCGC MORGENTHAU	AMERICAN	6	59.9 N	29.4 W	00	23	M 60	.25 NM	80	969.0	5.3	8.4	12	29.5			
MV PRINCE OF FUNDY	SWEDISH	7	43.7 N	67.0 W	18	30	45	> 25 NM	00	1002.8		8.0	10	16.5			
SS MOBIL EXPORTER	PANAMANIAN	7	37.5 N	59.0 W	12	33	60	2 NM	82	999.7	19.5	23.3	12	32.5			
SS SEALAND GALLOWAY	AMERICAN	7	41.1 N	60.4 W	12	03	50	5 NM	02	1015.2	12.7	18.4	6	14.5			
SS GREAT REPUBLIC	AMERICAN	7	41.5 N	59.0 W	12	01	45	5 NM	02	1007.8	12.0	17.0	8	24.5			
SS MOBIL EXPORTER	PANAMANIAN	8	35.5 N	59.2 W	00	32	45	5 NM	02	1007.0	19.5	23.9	9	32.5			
SS LASH ITALIA	AMERICAN	8	34.4 N	53.8 W	00	25	47	10 NM	03	1006.8	20.0	21.1	10	19.5			
SS MARSHFIELD	AMERICAN	8	36.7 N	52.5 W	00	14	45	5 NM	01	986.8	20.0	22.2	11	6.5	21	X	14.5
SS AMER LEGACY	AMERICAN	8	46.5 N	38.7 W	12	21	41	5 NM	02	1010.0	18.9	17.7	6	23			
MV MELVIN H BAKER	LIBERIAN	9	38.0 N	73.3 W	12	27	50	5 NM	01	1000.0	12.2	17.0	5	16.5			
SS DELAWARE GETTY	AMERICAN	9	37.9 N	74.6 W	12	30	45	10 NM	03	1007.0	13.0	16.1	4	11.5			
SS ESSO HUNTINGTON	AMERICAN	9	37.8 N	74.0 W	12	31	M 50	> 25 NM	03	1006.0	12.5	18.9	6	19.5			
SS ESSO MIAMI	AMERICAN	9	37.7 N	68.8 W	12	27	50	10 NM	18	999.9	19.0	25.5	12	16.5			
SS CHARLESTON	AMERICAN	9	38.6 N	74.2 W	12	32	45	10 NM	02	1002.4	10.0	12.8	7	11.5			
MV ISLAND PRINCESS	NORWEGIAN	9	35.0 N	66.7 W	06	23	45	10 NM	01	1006.0	21.8	24.0	3	6.5	XX	X	10
SS MOBIL EXPORTER	PANAMANIAN	9	35.3 N	66.6 W	12	25	M 45	> 25 NM	50	1004.5	22.5	23.5	10	16.5			
MV A N KEMP	LIBERIAN	10	35.5 N	60.8 W	18	30	50	10 NM	03	1001.7	21.0	22.2	8	16.5			
SS MOBIL EXPORTER	PANAMANIAN	10	35.8 N	69.0 W	06	32	M 45	5 NM	02	1008.0	18.0	24.4					
USCGC HAMILTON	AMERICAN	11	49.0 N	52.5 W	03	05	M 44	2 NM	10	1008.6	3.8	1.1	8	14.5			
SS STAGHOUND	AMERICAN	12	50.7 N	18.5 W	12	25	45	5 NM	02	998.9	13.7	13.4			25	9	19.5
MV CHRISTITSA	GREEK	12	44.4 N	53.2 W	00	02	45	1 NM	05	999.4	6.0	8.0	5	13			
SS RIO ORINOCO	LIBERIAN	12	46.8 N	08.9 W	12	23	46	5 NM	02	1012.5	16.2	14.4					
SS RIO ORINOCO	LIBERIAN	13	45.1 N	09.7 W	00	22	46	.5 NM	21	1012.9	15.5	15.6	6	19.5			
SS WILMINGTON GETTY	AMERICAN	14	35.1 N	74.8 W	18	20	55	2 NM	25	1001.7	24.0	21.2	8	11.5			
SS EXPORT FREEDOM	AMERICAN	14	37.4 N	47.9 W	12	28	45	10 NM	25	1005.0	20.6	21.1	5	6.5	28	8	24.5
SS EXPORT AIDE	AMERICAN	14	37.6 N	45.7 W	18	27	42	5 NM	62	1004.1	17.8	20.5	5	16.5	29	>13	19.5
MV MAYA	MEXICAN	14	23.6 N	95.9 W	18	01	M 50	5 NM	03	1014.0	27.0	29.0	5	6.5			
SS EXPORT FREEDOM	AMERICAN	15	37.7 N	59.2 W	18	20	45	5 NM	03	999.0	21.8	22.2	6	11.5	21	10	13
SS EXPORT AIDE	AMERICAN	15	37.4 N	53.8 W	18	23	52	10 NM	01	1008.5	21.7	21.7	6	14.5			
SS WILMINGTON GETTY	AMERICAN	15	34.8 N	74.6 W	00	27	58	5 NM	02	1002.4	25.0	25.0	9	11.5			
SS EXPORT AIDE	AMERICAN	16	38.2 N	60.1 W	18	31	50	10 NM	03	1009.8	16.8	16.6	9	14.5			
USCGC DALLAS	AMERICAN	16	47.0 N	52.4 W	12	26	M 45	10 NM	02	989.0	5.0	7.2	5	5			
SS OCEANIC	PANAMANIAN	17	36.1 N	74.8 W	18	01	45	5 NM	02	1004.4	14.4	17.8	3	16.5			
USCGC DALLAS	AMERICAN	17	43.6 N	43.3 W	21	25	M 42	5 NM	03	1016.6	13.8	10.6	8	14.5			
USCGC BOUTWELL	AMERICAN	17	50.6 N	42.7 W	18	24	M 45	5 NM	14	997.6	5.3	11.7	9	18			
SS BIENVILLE	AMERICAN	18	37.2 N	72.5 W	00	34	50	2 NM	65	1002.0	19.5	26.2	5	14.5	XX	X	24.5
MV BELGIAN REEFER	DANISH	18	40.2 N	62.9 W	12	08	50	.5 NM	82	994.8	17.0	22.0	8	23			
MV MAYA	MEXICAN	18	27.3 N	95.4 W	12	14	M 55	2 NM	02	1008.0	25.0	27.0	5	13			
SS PORTLAND	AMERICAN	18	37.5 N	72.6 W	06	35	60	5 NM	02	998.0	12.8	24.4		19.5	03	X	24.5
SS KENAI PENINSULA	LIBERIAN	18	34.2 N	70.8 W	06	36	56	5 NM	60	1010.0	20.6	22.8	8	16.5			
MV LEMPA	HONDURAN	19	45.7 N	14.7 W	18	29	44	10 NM	25	1000.0	12.0	14.0	9	32.5			
USCGC TANEY	AMERICAN	19	40.9 N	50.8 W	09	23	M 53	5 NM	02	1000.7	17.8	20.5	12	18			
MV BELGIAN REEFER	DANISH	19	39.0 N	58.7 W	06	30	45	2 NM	25	1011.2	14.5		15	39			
SS AMER LEGACY	AMERICAN	19	40.8 N	54.1 W	06	25	45	10 NM	02	998.3	17.2	18.8	10	26			
SS MAUMEE	AMERICAN	20	32.4 N	77.1 W	06	15	45	1 NM	82	1010.2	22.8	27.2	7	11.5	20	7	13
MV LEMPA	HONDURAN	20	45.5 N	15.4 W	00	29	42	10 NM	02	1005.1	13.2	14.0	9	32.5			
SS RIO BARIMA	LIBERIAN	20	57.5 N	24.0 W	18	34	48	10 NM		994.9	8.0	10.0	5	19.5			
SS AMER LEGACY	AMERICAN	20	41.8 N	44.0 W	06	26	45	5 NM	02	992.2	14.0	20.0	10	26			
MV BELGIAN REEFER	DANISH	20	39.2 N	48.5 W	12	32	45	10 NM	02	1014.5	14.0	21.0	10	19.5			
MV LAPLAND	BRITISH	21	37.2 N	41.7 W	12	32	41	10 NM	01	1012.5	18.7	22.0	7	10	31	11	26
USCGC MORGENTHAU	AMERICAN	21	44.5 N	63.4 W	00	16	M 41	.25 NM	61	998.7	10.2	7.8	6	13			
USCGC TANEY	AMERICAN	21	38.5 N	62.7 W	06	21	M 32	1 NM	95	1004.5	21.4	24.4	9	14.5			
SS LOUISE	PANAMANIAN	22	48.0 N	61.2 W	06	29	45	2 NM	26	999.7	- 1.0	5.0					
MV LAPLAND	BRITISH	23	34.0 N	60.6 W	18	33	45	2 NM	82	1001.0	17.0	22.0	6	11.5			
SS AMER LEADER	AMERICAN	23	42.0 N	58.5 W	18	01	48	1 NM	61	988.5	7.2		9	19.5			
SS SEALAND MC LEAN	AMERICAN	23	41.2 N	58.7 W	18	05	41	2 NM	61	980.0	12.5	18.3	6	14.5			
MV LAPLAND	BRITISH	24	35.3 N	62.1 W	00	33	43	2 NM	82	1007.0	14.5	22.0	6	18			
SS JOSEPH LYKES	AMERICAN	24	28.5 N	93.1 W	18	09	M 45	2 NM	61	1017.0	14.4	17.2	6	11.5			
MV PERNDALE	NORWEGIAN	24	41.8 N	50.0 W	06	24	50	10 NM	02	981.0	10.0		10	19.5			
MV SAN BLAS	SWEDISH	25	48.8 N	33.9 W	00	17	48	2 NM	62	1004.0	13.3		5	16.5			
SS AMER ACE	AMERICAN	26	37.5 N	72.3 W	12	15	45	5 NM	25	999.3	18.9	16.7	5	6.5			
SS AMER ALLIANCE	AMERICAN	26	45.3 N	41.0 W	00	19	42	2 NM	81	1003.7	14.0	17.8	8	16.5	19	10	19.5
SS ATLANTIC PRESTIGE	AMERICAN	26	32.3 N	77.7 W	06	20	45	2 NM	50	1001.4	24.0	24.4	3	13	20	13	19.5
SS CHARLESTON	AMERICAN	26	35.3 N	75.2 W	06	14	50	2 NM	65	999.0	17.3	17.7					
SS MOBIL FUEL	AMERICAN	26	39.2 N	70.5 W	12	20	45	1 NM	10	1000.7	16.3	21.0	10	13			
MV SUMIMA	NORWEGIAN	27	32.1 N	68.1 W	06	20	42	2 NM	81	1011.8	22.0	23.0	10	6.5			
MV MAR MERON	ISRAEL	27	36.6 N	61.8 W	12	19	50	2 NM	02	1018.0	21.5	20.8	8	23			
SS CHARLESTON	AMERICAN	27	33.7 N	77.2 W	00	24	60	5 NM	02	1005.4	12.8	23.3	8	14.5			
SS ORE NEPTUNE	LIBERIAN	27	35.0 N	73.0 W	12	27	45	10 NM	01	1014.0	15.5	22.2	5	16.5			
USCGC BOUTWELL	AMERICAN	27	54.1 N	30.5 W	18	29	61	5 NM	16	1020.2	4.8	8.3	11	29.5			
USCGC BOUTWELL	AMERICAN	28	54.5 N	29.6 W	00	27	47	5 NM	07	1021.7	6.1	8.7	11	29.5			
USCGC BOUTWELL	AMERICAN	29	54.1 N	31.5 W	15	29	50	5 NM	15	1002.0	5.5	8.9	10	24.5			
OCEAN STATION VESSELS																	
ATLANTIC B																	
USCGC SHERMAN	AMERICAN	5	56.3 N	50.8 W	21	29	M 41	5 NM	85	1013.6	- 0.1	3.4	9	24.5			
USCGC HAMILTON	AMERICAN	16	56.5 N	50.7 W	18	10	M 36	.5 NM	07	989.6	3.7	3.7	10	29.5			
USCGC HAMILTON	AMERICAN	17	56.5 N	50.0 W	00	09	M 38	.5 NM	07	981.0	4.3	3.7	12	31			
USCGC HAMILTON	AMERICAN	22	56.5 N	50.5 W	21	20	M 53	5 NM	02	978.1	1.2	3.4	8	14.5			
USCGC HAMILTON	AMERICAN	24	56.5 N	51.0 W	21	05	M 42	5 NM	77	982.0	1.7	3.6	5	10			
USCGC HAMILTON	AMERICAN	25	56.2 N	50.7 W	15	33	M 45	5 NM	71	979.0	2.1	3.6	7	14.5	04	7	11.5
USCGC HAMILTON	AMERICAN	26	56.3 N	51.0 W	03	32	M 42	.5 NM	71	1003.1	- 2.3	3.6	9	19.5			
USCGC HAMILTON	AMERICAN	27	55.6 N	51.3 W	21	20	M 44	1 NM	61	977.5	5.2	2.8	7	19.5			
USCGC HAMILTON	AMERICAN	28	56.2 N	51.0 W	06	22	M 62	1 NM	07	971.0	3.6	2.8	9	26			
USCGC HAMILTON	AMERICAN	29	56.4 N	50.9 W	00	28	M 47	5 NM	71	997.6	1.2	3.3	7	16.5			
USCGC HAMILTON	AMERICAN	30	56.4 N	50.7 W	21	31	M 42	5 NM	85	1005.3	- 1.3	3.1	6	10			

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves Period sec	Sea Waves Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH ATLANTIC OCEAN		NOV.															
ATLANTIC C																	
USCGC BOUTWELL	AMERICAN	18	52.4 N	36.4 W	21	30	M 47	5 NM	80	985.7	6.8	8.3	9	21			
USCGC BOUTWELL	AMERICAN	19	52.5 N	35.5 W	00	02	M 42	10 NM	02	994.0	6.0	8.3	7	19.5			
USCGC BOUTWELL	AMERICAN	23	52.5 N	35.5 W	18	17	M 41	2 NM	51	1006.4	10.0	8.3	8	14.5			
USCGC BOUTWELL	AMERICAN	25	54.1 N	32.7 W	03	17	M 41	2 NM	61	1001.0	10.3	8.3	8	14.5			
USCGC BOUTWELL	AMERICAN	26	52.6 N	35.5 W	15	24	M 52	2 NM	07	984.0	7.9	8.0	8	16.5			
ATLANTIC D																	
USCGC TANEY	AMERICAN	17	43.5 N	43.1 W	18	27	M 41	10 NM	02	1014.4	15.0	18.8	8	11.5			
USCGC DALLAS	AMERICAN	20	43.9 N	41.3 W	18	03	44	5 NM	25	999.8	14.5	17.7	10	18			
USCGC DALLAS	AMERICAN	22	44.0 N	41.1 W	18	15	44	10 NM	02	1005.3	16.0	16.3	7	13			
ATLANTIC H																	
USCGC GRESHAM	AMERICAN	8	38.0 N	71.0 W	21	23	47	2 NM	25	995.7	17.8	20.2	12	19.5			
USCGC GRESHAM	AMERICAN	9	38.0 N	71.0 W	03	26	45	5 NM	13	999.2	17.1	19.4	6	13	18	10	11.5
USCGC GRESHAM	AMERICAN	17	38.0 N	71.0 W	21	06	47	2 NM	61	1002.4	13.3	15.6	7	11.5			
USCGC GRESHAM	AMERICAN	18	38.0 N	71.0 W	00	03	50	2 NM	61	999.0	13.8	16.2	10	19.5			
USCGC GRESHAM	AMERICAN	20	38.0 N	71.0 W	12	17	41	5 NM	25	1009.1	20.1	17.5	8	14.5			
USCGC SPENCER	AMERICAN	26	38.0 N	71.0 W	15	18	M 54	.5 NM	61	994.0	19.9	20.2	7	16.5	21	12	19.5
GREAT LAKES VESSELS																	
SS J L MAUTHE	AMERICAN	8	48.2 N	87.5 W	00	03	M 44	5 NM	02		1.0	6.0		13			
SS ARTHUR M ANDERSON	AMERICAN	23	47.4 N	87.4 W	18	26	M 41	10 NM	02		0.0	6.0	5	14.5			
SS JOHN SHERWIN	AMERICAN	23	47.2 N	87.6 W	12	27	M 48	10 NM	02		1.0	4.0	5	10			
SS ERNEST T WEIR	AMERICAN	24	44.2 N	82.9 W	06	24	M 42	10 NM	02		0.0	7.0	10	10			
NORTH ATLANTIC		DEC.															
SS RIO MACAREO	LIBERIAN	1	42.0 N	28.8 W	18	35	42	10 NM	03	1016.2	11.1	16.7	8	19.5			
SS GULFCREST	AMERICAN	1	39.9 N	70.2 W	18	28	45	10 NM	02	1004.1	8.9	16.1	6	11.5			
SS MOBIL FUEL	AMERICAN	1	36.1 N	72.6 W	18	29	45	5 NM	02	1012.5	12.2	23.3					
USCGC BOUTWELL	AMERICAN	2	51.4 N	39.9 W	15	27	M 60	1 NM	07	989.2	8.8	12.2	10	24.5			
SS RIO BARIMA	LIBERIAN	2	43.0 N	64.5 W	06	25	48	10 NM	01	1003.7	6.0	8.9	5	19.5			
SS GULFCREST	AMERICAN	2	41.1 N	69.2 W	00	28	50	10 NM	01	1008.5	6.7	8.9	6	11.5			
MV ANNA REHDER	GERMAN	2	54.4 N	47.7 W	18	21	48	1 NM		963.5	1.5	5.0	8	13			
SS ADM W M CALLAGHAN	AMERICAN	2	40.2 N	62.7 W	00	26	45	2 NM	25	1000.7	15.0	19.5	9	10	25	10	14.5
SS ORE MERCURY	LIBERIAN	2	49.5 N	65.5 W	00	04	45	.5 NM	26	969.5		0.0	6	16.5	04	12	19.5
USCGC BOUTWELL	AMERICAN	3	50.9 N	41.5 W	03	24	M 62	2 NM	07	987.6	3.8	8.3	12	26			
USCGC DALLAS	AMERICAN	3	46.1 N	47.0 W	15	27	45	10 NM	15	1016.8	3.0	6.1	9	19.5			
USCGC BOUTWELL	AMERICAN	4	49.7 N	47.2 W	18	28	M 49	5 NM	26	1003.9	- 4.2	6.7	12	23			
USCGC DALLAS	AMERICAN	4	47.1 N	49.8 W	03	19	44	2 NM	07	999.0	6.4	1.7	7	14.5			
SS RIO MACAREO	LIBERIAN	4	50.0 N	13.5 W	12	31	41	10 NM	27	1000.4	8.3	13.4	7	16.5			
MV CHRISTITSA	GREEK	4	49.0 N	25.8 W	18	27	55	5 NM	02	1009.4	11.0	15.0					
SS AMER LEGACY	AMERICAN	4	53.8 N	40.8 W	18	25	41	10 NM	88	984.4	- 2.3	5.5	10	26			
MV JANOVA	NORWEGIAN	4	43.9 N	35.2 W	18	23	M 45	5 NM	03	1012.5	16.2	16.0		23			
USCGC BOUTWELL	AMERICAN	5	49.4 N	47.7 W	00	28	M 45	5 NM	07	1008.0	- 4.0	5.0	12	24.5			
MV CHRISTITSA	GREEK	5	48.9 N	26.0 W	00	29	50	10 NM	81	1009.7	10.0	14.0					
SS AMER ACCORD	AMERICAN	5	49.2 N	23.7 W	12	26	45	10 NM	02	1000.3	8.9	12.2	8	16.5	26	12	23
SS AMER LEGACY	AMERICAN	5	49.7 N	46.8 W	18	28	45	10 NM	87	1013.5	0.0	6.0	10	26			
SS RIO MACAREO	LIBERIAN	6	54.5 N	05.4 W	00	25	42	10 NM	02	991.5	7.3	11.3	7	10			
MV CHRISTITSA	GREEK	6	47.8 N	28.2 W	00	29	50	10 NM	80	1000.1	2.0	15.0					
SS AMER ALLIANCE	AMERICAN	6	50.1 N	11.1 W	18	24	43	5 NM	13	999.0	9.5	11.6					
MV PENDRECHT	NETHERLANDS	7	33.7 N	45.0 W	18	06	41	5 NM	15	1027.0	19.3	21.8	6	14.5			
USCGC BOUTWELL	AMERICAN	8	49.9 N	46.8 W	21	27	M 50	2 NM	85	1026.5	- 4.0	7.2	11	23			
MV JANOVA	NORWEGIAN	8	41.7 N	57.3 W	00	33	M 48	5 NM	02	1026.0	10.0	12.0		16.5			
USCGC HAMILTON	AMERICAN	8	51.5 N	50.2 W	15	28	M 50	5 NM	26	1016.0	- 9.2	1.7	9	21			
SS ORE MERCURY	LIBERIAN	8	49.4 N	65.0 W	00	29	45	10 NM	02	1032.5		0.5	8	16.5	27	>13	24.5
USCGC HAMILTON	AMERICAN	9	50.9 N	47.3 W	03	28	M 56	2 NM	85	1021.6	- 4.2	1.7	10	21			
USCGC BOUTWELL	AMERICAN	9	50.3 N	47.0 W	00	27	M 54	2 NM	85	1024.2	- 2.8	4.4	10	23			
USCGC HAMILTON	AMERICAN	10	50.8 N	43.2 W	18	28	M 54	5 NM	15	995.5	1.1	10.0	10	21			
USCGC HAMILTON	AMERICAN	11	50.6 N	42.5 W	03	29	M 48	5 NM	85	1003.3	0.6	10.6	10	23			
MV PENDRECHT	NETHERLANDS	11	43.4 N	16.6 W	18	22	41	2 NM	61	1015.3	14.3	13.8	8	14.5			
SS AMER ALLIANCE	AMERICAN	11	41.8 N	57.0 W	18	32	47	10 NM	80	1007.1	10.0	16.2	9	13	32	9	13
USCGC HAMILTON	AMERICAN	12	48.5 N	46.2 W	09	28	M 48	1 NM	85	1001.6	- 5.3	3.9	6	8	33	9	16.5
SS ORE MERCURY	LIBERIAN	12	48.5 N	30.2 W	12	28	65	.5 NM	27	987.0		14.0	14	34.5			
MV PENDRECHT	NETHERLANDS	12	46.7 N	09.2 W	18	20	44	2 NM	61	1013.0	13.7	12.9	9	16.5			
SS GREAT REPUBLIC	AMERICAN	12	40.1 N	30.0 W	12	18	50	2 NM	21	1010.0	20.5	14.0	6	16.5	20	8	23
SS AMER ALLIANCE	AMERICAN	12	41.3 N	58.3 W	00	36	45	10 NM	01	1018.0	7.1	11.1	9	19.5			
MV SUNIMA	NORWEGIAN	12	50.7 N	23.4 W	18	24	50	2 NM	64	984.8	6.5	10.0	12	24.5			
SS GREAT REPUBLIC	AMERICAN	13	40.4 N	39.2 W	12	28	55	5 NM	07	1010.5	10.0	15.7	8	24.5	28	8	29.5
MV SUNIMA	NORWEGIAN	13	51.3 N	22.2 W	00	23	60	2 NM	01	992.1	6.8	10.0	20	47.5			
USCGC HAMILTON	AMERICAN	14	45.2 N	59.6 W	03	30	M 54	2 NM	07	999.5	0.9	2.8	6	13			
USCGC CHAUTAUQUA	AMERICAN	14	46.6 N	52.5 W	06	35	M 42	5 NM	02	990.2	- 0.9	1.7	9	13			
MV MOSBAY	NORWEGIAN	14	36.5 N	46.0 W	12	26	M 44	10 NM	02	1017.0	20.0	21.0		10			
SS GREAT REPUBLIC	AMERICAN	14	40.6 N	44.6 W	12	26	65	1 NM	07	997.5	14.0	16.3			26	8	39
SS CRISTOFORO COLOMBO	ITALIAN	14	42.3 N	38.4 W	15	27	55	1 NM	05	978.0	13.0	17.0	6	16.5			
SS AMER ACE	AMERICAN	14	41.0 N	35.0 W	18	26	64	1 NM	25	984.3	12.2	16.7	14	32.5			
SS AMER LEGACY	AMERICAN	14	41.8 N	51.6 W	12	29	45	5 NM	01	1010.0	12.1	15.2	10	23			
SS SEALAND GALLOWAY	AMERICAN	14	42.2 N	37.5 W	18	32	60	200 YD	18	979.0	11.5	8.3	14	11.5	32	>13	44
MV WESER ORE	LIBERIAN	14	42.7 N	28.5 W	18	20	43	1 NM	54	991.2	10.0	16.0	8	16.5			
SS GREAT REPUBLIC	AMERICAN	15	40.9 N	52.0 W	18	34	42	10 NM	71	1016.3	5.5	16.2	7	16.5			
SS AMER ACE	AMERICAN	15	40.5 N	36.9 W	12	28	60	10 NM	25	998.6	10.0	15.6	6	24.5	28	8	26
SS CRISTOFORO COLOMBO	ITALIAN	15	42.5 N	34.0 W	00	27	55	1 NM	05	985.0	9.0	16.0	6	16.5			
SS AMER LEGACY	AMERICAN	15	43.8 N	38.8 W	18	30	50	1 NM	69	991.0	1.4	14.4	12	32.5	30	11	32.5
SS ATLANTIC PRESTIGE	AMERICAN	15	34.7 N	75.3 W	18	19	45	10 NM	18	1008.8	24.5	26.7	2	6.5			
SS SL 181	AMERICAN	15	41.5 N	30.9 W	18	26	45	5 NM	50	989.5	7.8	15.6			27	10	41
SS ORE MERCURY	LIBERIAN	15	48.7 N	11.0 W	00	16	45	5 NM	02	1009.5		12.2	6	16.5	16	10	19.5
MV MOSBAY	NORWEGIAN	15	36.3 N	37.4 W	18	27	M 49	10 NM	01	1006.0	19.0	20.0		14.5			
SS ESSO BANGOR	AMERICAN	16	28.0 N	92.2 W	00	36	M 45	5 NM	02	1028.4	12.5	23.3	6	13			
SS GREAT REPUBLIC	AMERICAN	16	41.5 N	60.0 W	12	10	41	2 NM	51	1009.1	6.0	15.5	5	14.5			
SS DOLLY TURMAN /NEW/	AMERICAN	16	23.8 N	88.6 W	12	02	M 43	5 NM	02	1023.0	20.5	25.0	8	13			
MV PORT DE FRANCE	FRENCH	16	34.7 N	74.4 W	06	22	45	5 NM	03	1002.0	23.8	26.0	9	13			
SS EXPORT FREEDOM	AMERICAN	16	37.0 N	17.3 W	18	23	45	5 NM	15	1000.0	18.0	16.7	8	19.5	27	8	19.5
SS CALIFORNIAN	AMERICAN	16	37.0 N	72.8 W	18	31	43	10 NM	02	1005.8	5.0	23.9	3	11.5	30	7	16.5
USCGC DALLAS	AMERICAN	16	42.4 N	48.0 W	00	29	45	5 NM	15	1016.0	1.5	16.7	10	26			
SS TOPA TOPA	AMERICAN	16	27.6 N	88.6 W	12	01	43	5 NM	02	1025.1	16.2	25.7	8	10	36	11	11.5
SS SOHIO INTREPID	AMERICAN	16	36.7 N	70.5 W	18	29	60	5 NM	02	1002.7	8.9	20.0	10	19.5			
SS STAGHOUND	AMERICAN	16	42.9 N	42.1 W	12	31	45	10 NM	68	1016.2	1.1	17.8	3	6.5	32	6	16.5

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves Period sec	Sea Waves Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH ATLANTIC OCEAN		DEC.															
SS AMER ACE	AMERICAN	16	40.5 N	39.5 W	00	31	50	5 NM	23	996.3	5.6	16.7	6	19.5	29	8	23
MV JANOVA	NORWEGIAN	16	30.2 N	77.7 W	18	32	M 48	5 NM	01	1019.8	14.5	24.0		23			
SS ORE SATURN	LIBERIAN	16	41.0 N	15.3 W	00	20	47	5 NM	02	1008.8	18.0	14.5	5	13	23	7	16.5
SS ORE TRANSPORT	LIBERIAN	16	34.2 N	72.5 W	06	22	45	5 NM	02	1003.1	23.7	23.3	6	10			
MV MOSBAY	NORWEGIAN	16	36.2 N	32.0 W	12	32	M 50	2 NM	03	1002.2	10.0	19.0		19.5			
USNS VICTORIA	AMERICAN	17	34.0 N	62.5 W	18	27	45	5 NM	25	1011.5	13.4	21.7	5	11.5	28	12	28
SS IDELLA LYKES	AMERICAN	17	21.4 N	85.6 W	18	04	41	5 NM	02	1024.4	25.0	27.8	8	11.5	05	11	18
SS SOHIO INTREPID	AMERICAN	17	37.2 N	71.5 W	00	29	50	5 NM	02	1006.4	5.0	20.5	7	8	XX	X	10
USCGC DALLAS	AMERICAN	17	41.3 N	60.7 W	18	28	55	2 NM	26	992.3	7.0	15.6	9	29.5			
MV ROLAND	SWEDISH	17	38.3 N	58.6 W	12	27	45	5 NM	81	997.0	15.3	21.0	6	13			
SS RUTH LYKES NEW	AMERICAN	17	19.3 N	83.6 W	18	03	45	5 NM	02	1018.6	23.8	26.7	6	8	03	8	11.5
MV SEA WITCH	AMERICAN	17	42.1 N	62.1 W	00	27	43	5 NM	01	992.8	0.0	11.6	5	11.5	26	9	29.5
SS ESSO PUERTO RICO	PANAMANIAN	17	38.3 N	73.6 W	00	31	M 51	5 NM	03		0.0	26.9	XX	16.5			
SS ESSO BOSTON	AMERICAN	17	25.2 N	86.4 W	00	04	45	10 NM	02	1028.1	17.0	26.2	13	14.5			
SS ERIC K HOLZER	AMERICAN	17	30.0 N	70.0 W	12	32	50	10 NM	03	1019.3	19.5	23.5	4	16.5			
SS DOLLY TURMAN /NEW/	AMERICAN	17	25.2 N	90.6 W	00	03	M 44	5 NM	02	1030.8	17.5	22.7	8	18			
SS GREAT REPUBLIC	AMERICAN	17	42.4 N	65.5 W	12	27	48	< 50 YD	86	993.6	- 2.5	5.5	8	24.5			
SS CALIFORNIAN	AMERICAN	17	39.4 N	73.5 W	12	31	50	5 NM	07	1020.0	- 2.3	12.7	6	16.5			
SS AMER ACE	AMERICAN	17	40.4 N	48.8 W	12	23	47	5 NM	01	995.0	18.3	17.8	5	11.5			
SS DELTA URUGUAY	AMERICAN	17	21.9 N	86.3 W	12	04	55	5 NM	07	1026.0	18.9	27.2	9	19.5			
SS LOUISE	PANAMANIAN	17	37.3 N	69.3 W	12	25	50		44	1010.8	4.5	22.8	XX	19.5	29	9	24.5
SS MORMACCOVE	AMERICAN	17	38.7 N	70.7 W	18	30	45	1 NM	27	1006.8	3.6	20.5	6	19.5	30	9	23
MV ROLAND	SWEDISH	18	38.7 N	54.7 W	00	28	45	.5 NM	81	1000.5	13.5	19.0	6	14.5			
MV PRINCE OF FUNDY	SWEDISH	18	43.7 N	66.8 W	18	25	50	5 NM	02	1012.5	3.0	8.0	10	24.5			
SS AMER ACE	AMERICAN	18	40.3 N	52.8 W	12	32	50	5 NM	21	1005.1	7.2	20.0	5	14.5	32	8	24.5
SS ERIC K HOLZER	AMERICAN	18	32.7 N	71.0 W	00	32	45	10 NM	02	1026.1	11.0	21.5	4	16.5	32	>13	24.5
SS SL 181	AMERICAN	18	38.9 N	49.7 W	12	27	45	5 NM	81	1003.4	10.0	18.9	8	13	28	10	26
SS SL 180	AMERICAN	18	38.3 N	70.1 W	00	30	45	2 NM	00	1024.0	1.7	15.6	5	11.5	32	7	14.5
USCGC DALLAS	AMERICAN	18	41.0 N	61.4 W	00	29	50	2 NM	85	1000.0	4.8	15.6	8	28			
SS LOUISE	PANAMANIAN	18	38.1 N	67.5 W	00	32	45	1 NM	27	1016.3	4.5	21.8	8	24.5			
SS AMER ACE	AMERICAN	19	40.2 N	58.1 W	12	30	48	10 NM	02	1013.5	11.1	19.4	5	14.5	27	9	26
SS ESSO WASHINGTON	AMERICAN	22	35.0 N	74.2 W	12	23	45	2 NM	18	1000.7	25.0	20.0					
MV ATLANTIC FOREST	NORWEGIAN	23	45.5 N	38.4 W	18	22	M 60	1 NM	63	990.0	15.0	14.0		29.5			
SS ADM W M CALLAGHAN	AMERICAN	23	40.6 N	62.6 W	06	23	47	2 NM	25	1005.0	13.9	16.8	3	10	23	7	19.5
SS AMER ARGOSY	AMERICAN	23	45.1 N	46.3 W	18	28	45	.5 NM	45	997.0	4.5	3.0	8	24.5	28	8	24.5
SS AMER ALLIANCE	AMERICAN	24	48.9 N	22.6 W	06	18	50	2 NM	60	988.5	8.8	12.2					
MV ATLANTIC FOREST	NORWEGIAN	24	45.8 N	36.4 W	00	26	M 65	1 NM	62	986.5	11.4	14.0		29.5			
SS SEALAND MC LEAN	AMERICAN	24	43.3 N	27.0 W	18	29	45	5 NM	16	1000.7	10.6	12.2	7	11.5	29	9	14.5
SS AMER ALLIANCE	AMERICAN	25	50.1 N	15.8 W	06	18	42	5 NM	01	985.0	10.0	12.8	9	14.5			
MV SKOGSTAD	NORWEGIAN	26	43.5 N	21.6 W	12	26	50	5 NM	03	988.0	12.2	12.0					
SS AMER LEGACY	AMERICAN	26	45.0 N	25.0 W	12	34	65	50 YD		974.0	9.4	14.0	14	49			
SS ALMERICA LYKES NEW	AMERICAN	26	40.7 N	19.7 W	18	30	44	5 NM	15	1000.0	12.3	12.8	6	14.5	27	12	21
MV ATLANTIC FOREST	NORWEGIAN	26	45.6 N	18.9 W	06	16	M 41	2 NM	81	982.5	10.6	12.0		24.5	28	X	32.5
MV SUNIMA	NORWEGIAN	27	45.8 N	14.8 W	00	23	45	2 NM	80	974.0	13.0	12.0					
MV ANNA REHDER	GERMAN	27	44.8 N	08.2 W	12	26	52	2 NM	25	996.0	12.5	12.0	10	19.5			
MV ROLAND	SWEDISH	27	44.1 N	13.8 W	06	28	53	2 NM	81	988.0	12.5	12.0	7	13			
MV RIGOLETTO	SWEDISH	27	42.7 N	13.7 W	06	27	44	10 NM	02	1006.6	11.2	10.0					
MV MEMNON	BRITISH	27	47.6 N	06.5 W	18	25	46	2 NM	65	985.1	12.8	28.3	6	10	23	10	29.5
SS AMER LEGACY	AMERICAN	28	43.0 N	44.3 W	18	23	45	2 NM	25	999.0	18.1	17.8	8	26			
MV ROLAND	SWEDISH	28	44.3 N	15.5 W	00	31	45	5 NM	81	1018.5	12.5	11.0	8	13			
USCGC CHAUTAUQUA	AMERICAN	28	47.1 N	51.1 W	21	29	M 43	5 NM	85	986.6	- 2.3	0.9	7	11.5	15	7	8
MV MEMNON	BRITISH	28	50.2 N	08.6 W	12	32	55	2 NM	01	1004.4	12.2	12.2	10	29.5			
USCGC INGHAM	AMERICAN	29	50.9 N	40.0 W	03	21	M 60	1 NM	07	979.7	7.2	7.2	7	26			
SS AMER LEGACY	AMERICAN	29	42.9 N	46.0 W	00	27	45	5 NM	01	1001.0	14.5	16.7	6	16.5	27	8	23
OCEAN STATION VESSELS																	
ATLANTIC B																	
USCGC HAMILTON	AMERICAN	1	56.5 N	51.0 W	00	29	M 43	5 NM	85	1008.6	- 2.4	3.1	6	13			
USCGC HAMILTON	AMERICAN	2	55.2 N	50.4 W	09	13	M 58	1 NM	68	969.6	1.2	3.6	7	14.5			
USCGC HAMILTON	AMERICAN	3	56.6 N	53.5 W	18	27	M 44	2 NM	85	964.5	- 1.3	2.6	7	11.5	23	10	11.5
USCGC DUANE	AMERICAN	8	55.5 N	51.1 W	12	27	M 45	200 YD	74	1000.6	-10.0	4.4	11	21			
USCGC DUANE	AMERICAN	9	55.0 N	51.4 W	03	26	M 49	5 NM	26	997.7	-10.9	3.7	11	26			
USCGC DUANE	AMERICAN	18	56.3 N	51.3 W	00	04	M 53	.5 NM	71	939.2	0.2	3.3	9	13			
USCGC DUANE	AMERICAN	19	56.2 N	51.2 W	00	31	M 49	5 NM	02	963.4	- 2.0	3.9	9	16.5	19	8	11.5
USCGC DUANE	AMERICAN	29	56.4 N	51.0 W	03	35	M 50	5 NM	02	986.5	- 3.9	3.3	10	21			
USCGC DUANE	AMERICAN	31	56.4 N	50.1 W	21	30	M 48	5 NM	02	1010.4	- 2.9	2.8	13	28			
ATLANTIC C																	
USCGC BOUTWELL	AMERICAN	1	52.6 N	35.7 W	12	31	M 48	10 NM	02	1006.6	4.8	8.3	10	19.5			
USCGC INGHAM	AMERICAN	15	51.3 N	35.3 W	09	05	M 55	2 NM	61	959.3	3.9	8.9	11	21			
USCGC INGHAM	AMERICAN	18	53.9 N	35.3 W	12	21	M 48	5 NM	80	980.3	3.5	8.6	8	14.5	XX	X	13
USCGC INGHAM	AMERICAN	19	51.9 N	37.2 W	21	23	M 55	5 NM	23	985.2	2.6	7.0	10	23	XX	X	10
USCGC INGHAM	AMERICAN	20	51.9 N	37.3 W	00	23	M 47	5 NM	68	995.0	2.5	7.0	10	23	XX	X	10
USCGC INGHAM	AMERICAN	23	52.1 N	37.4 W	21	12	M 50	2 NM	61	965.6	7.1	6.8	12	24.5			
USCGC INGHAM	AMERICAN	24	51.8 N	36.8 W	09	32	M 65	2 NM	07	977.0	4.5	6.8	14	32.5	XX	X	16.5
ATLANTIC D																	
USCGC DALLAS	AMERICAN	11	44.1 N	41.2 W	21	25	50	5 NM	02	987.1	16.9	14.6	8	18			
USCGC DALLAS	AMERICAN	12	44.1 N	41.2 W	00	25	60	5 NM	07	991.8	10.8	14.6	9	21			
USCGC DALLAS	AMERICAN	13	43.9 N	41.3 W	15	32	48	2 NM	87	1011.8	3.8	15.0	10	23			
USCGC DALLAS	AMERICAN	14	43.7 N	41.6 W	18	29	85	1 NM	80	993.5	5.7	14.4	12	34			
USCGC DALLAS	AMERICAN	15	43.3 N	43.4 W	00	29	64	5 NM	85	1003.0	5.2	14.4	10	34.5			
USCGC CHAUTAUQUA	AMERICAN	23	44.1 N	41.0 W	18	22	M 55	1 NM	21	993.8	15.4	13.3	9	19.5			
USCGC CHAUTAUQUA	AMERICAN	24	44.0 N	41.3 W	00	29	M 45	2 NM	07	1005.5	10.6	13.3	9	19.5			
USCGC CHAUTAUQUA	AMERICAN	25	44.0 N	42.3 W	15	31	M 44	5 NM	80	998.0	9.3	14.4	8	14.5			
USCGC CHAUTAUQUA	AMERICAN	30	43.7 N	41.3 W	21	29	43	10 NM	02	1018.8	4.9	15.4	7	13			
ATLANTIC E																	
USCGC ANDROSCOGGIN	AMERICAN	14	35.1 N	48.1 W	15	27	M 42	5 NM	02	1015.3	20.2	22.2	8	19.5			
ATLANTIC H																	
USCGC SPENCER	AMERICAN	1	38.0 N	71.0 W	18	28	M 47	10 NM	01	1008.7	12.8	22.9	7	18			
USCGC SPENCER	AMERICAN	7	38.0 N	71.0 W	03	19	M 45	1 NM	63	1011.0	21.2	24.2	6	14.5			
USCGC GRESHAM	AMERICAN	11	38.0 N	71.0 W	00	26	M 42	5 NM	80	1015.0	21.3	25.1	6	10			
USCGC GRESHAM	AMERICAN	16	38.0 N	71.0 W	21	28	M 46	5 NM	16	1003.2	7.0	24.4	8	21	21	< 6	6.5
USCGC GRESHAM	AMERICAN	17	38.0 N	71.0 W	06	29	M 54	1 NM	85	1008.7	3.9	22.8	8	24.5			

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C: Air	Temperature °C: Sea	Sea Waves+: Period sec	Sea Waves+: Height ft	Swell Waves: Dir. 10°	Swell Waves: Period sec	Swell Waves: Height ft
NORTH ATLANTIC OCEAN		DEC.															
USCGC GRESHAM	AMERICAN	18	38.0 N	71.0 W	00	32	M 47	.5 NM	85	1026.5	3.6	23.5	8	29.5			
GREAT LAKES VESSELS																	
SS G M HUMPHREY	AMERICAN	1	45.5 N	83.5 W	12	31	M 42	10 NM	01		- 5.0	6.0	3	8			
SS ENDERS M VOORHEES	AMERICAN	6	43.6 N	87.5 W	18	30	M 45	1 NM	28		-10.0	4.0	11	6.5			
SS G M HUMPHREY	AMERICAN	7	44.9 N	83.1 W	00	29	M 45	10 NM	02		-11.0	4.0	3	5			
SS PAUL H CARNAHAN	AMERICAN	13	44.3 N	82.8 W	06	24	M 48	10 NM	02			5.6	5	5			
SS JOHN DYKSTRA	AMERICAN	16	47.3 N	86.9 W	00	33	M 48	1 NM	74		- 4.0	3.0		8			
SS PAUL H CARNAHAN	AMERICAN	16	47.9 N	89.4 W	12	33	M 43	5 NM	02			3.3	5	5			
SS LEON FALK JR	AMERICAN	17	47.2 N	90.0 W	18	22	M 52	> 25 NM	03		- 5.0	3.0	5	11.5			
SS ARTHUR M ANDERSON	AMERICAN	17	47.2 N	90.2 W	18	22	M 49	> 25 NM	02		- 5.0	4.0	18	13			
SS J L MAUTHE	AMERICAN	18	47.4 N	89.3 W	00	26	M 42	> 25 NM	02		- 5.0	4.0	11	13			
SS ENDERS M VOORHEES	AMERICAN	30	47.4 N	91.0 W	18	06	M 50	2 NM	71		- 4.0	3.0	15	18			
SS LEON FRASER	AMERICAN	30	46.7 N	91.6 W	18	05	M 46	1 NM	75		- 3.0	4.0	8	21			
SS ENDERS M VOORHEES	AMERICAN	31	47.2 N	90.5 W	06	05	M 42	2 NM	71		- 3.0	3.0	15	24.5			
SS LEON FRASER	AMERICAN	31	47.1 N	91.2 W	00	07	M 50	1 NM	75		- 1.0	5.0	9	18			

+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

NOTE: These observations are selected from those with winds of 41 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U.S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

Table 16
U.S. Ocean Station Vessel Climatological Data, North Pacific

Ocean Weather Station 'NOVEMBER' 30°00'N 140°00'W November and December, 1972

MEANS AND EXTREMES

	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
MONTH	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
NOV	17.0	17 15	19.5	21.8	22 00	11.1	15 15	15.0	18.8	13 09	19.0	*27 21	20.6	22.6	*09 03	- 4.1	09 03	- 1.1	1.8	*27 21
DEC	16.0	31 06	19.2	21.8	11 21	9.2	29 00	15.7	19.8	19 00	17.3	*17 15	20.0	21.0	23 00	- 3.8	31 06	- .7	2.7	17 15

	MEANS AND EXTREMES: PRESSURE (MB)					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS): TOTAL CLOUD				LOW CLOUD				DAYS WITH SPECIFIED WEATHER										
MONTH	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
NOV	1018.5	14 00	1024.2	1030.0	25 18	21.0	17.6	39.5	21.9	32.2	21.0	27.9	18.9	9	9	0	0	0	0	0	0	28	4.3	233
DEC	1005.1	15 00	1019.6	1032.2	24 21	8.7	12.2	31.0	48.0	13.1	19.2	26.6	41.0	15	15	0	1	1	10	3	0	27	14.0	229

** VV-90-93 AND/OR W=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

NOV WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.6	2.9	11.6	2.4	.0	.0	17.5	14.5
NE	2.5	3.0	6.5	.3	.0	.0	12.3	10.7
E	1.2	1.5	9.2	6.1	.0	.0	18.0	18.1
SE	.0	5.6	1.8	.0	.0	.0	7.4	9.9
S	1.3	3.9	1.2	.3	.0	.0	6.7	8.2
SW	1.0	4.0	2.7	.1	.0	.0	7.7	9.7
W	.3	7.3	2.6	.0	.0	.0	10.2	7.8
NW	.0	6.7	5.2	1.1	.0	.0	12.9	11.6
CALM	7.3	.0	.0	.0	.0	.0	7.3	.0
TOTAL	14.2	34.8	40.8	10.3	.0	.0	100.0	12.1

NUMBER OF OBS 233; MAX WIND: DIR 100, SPEED 28, DA HR 29 1800; VECTOR SPEED 4.4; MEAN DIR 033 (DIR IN DEGREES)

DEC WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.3	.9	.0	.0	.0	1.2	11.2
NE	.0	.1	3.7	3.3	2.9	.0	10.0	27.3
E	.0	2.8	6.4	11.4	7.8	.3	28.7	26.3
SE	.0	3.2	14.3	6.1	1.6	.1	25.3	20.2
S	.0	.3	7.3	8.5	1.2	.0	17.4	23.0
SW	.0	2.3	5.2	3.5	.0	.0	11.0	18.4
W	.0	.8	3.9	.0	.0	.0	4.7	14.2
NW	.0	.7	.5	.0	.0	.0	1.2	9.5
CALM	.4	.0	.0	.0	.0	.0	.4	.0
TOTAL	.4	10.5	42.4	32.8	13.5	.4	100.0	22.4

NUMBER OF OBS 229; MAX WIND: DIR 060, SPEED 48, DA HR *07 0200; VECTOR SPEED 13.5; MEAN DIR 123 (DIR IN DEGREES)

Wave

NOV WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	10.4	14.5	3.9	.3	.0	.0	.0	29.1
NE	.0	1.5	1.9	1.0	.0	.0	.0	.0	4.4
E	.4	7.0	12.2	.0	.0	.0	.0	.0	19.6
SE	.0	1.8	.4	.0	.0	.0	.0	.0	2.3
S	.0	.4	.3	.0	.0	.0	.0	.0	.8
SW	1.1	.9	1.5	.0	.0	.0	.0	.0	3.4
W	.6	4.1	1.7	.0	.0	.0	.0	.0	6.4
NW	.0	13.8	16.7	2.0	.3	.0	.0	.0	33.2
IND	.0	.9	.0	.0	.0	.0	.0	.0	.9
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.1	40.8	49.4	6.9	.9	.0	.0	.0	100.0

NUMBER OF OBS 233 IND=INDETERMINATE

DEC WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	.0	.0	.0	.0	.0	.0	.0	.0
NE	.0	.0	.0	.2	3.6	2.0	.0	.0	5.8
E	.0	2.3	4.5	3.3	9.4	2.6	.8	.0	22.9
SE	.0	10.4	4.7	.3	4.8	.0	.1	.0	20.7
S	.0	3.5	3.3	2.4	5.1	.0	.0	.0	14.4
SW	.0	4.1	4.0	1.4	.7	.0	.0	.0	10.3
W	.0	8.0	3.7	1.7	.4	.0	.0	.0	13.9
NW	.0	9.1	.9	.0	.0	.0	.0	.0	9.9
IND	.0	.4	.0	.0	.0	.0	.0	.0	.4
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.0	38.0	23.1	9.6	24.0	4.4	.9	.0	100.0

NUMBER OF OBS 229 IND=INDETERMINATE

NOV WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.9	9.9	3.4	1.3	.0	.0	.0	.0	15.5
6-7	.9	12.0	18.9	.4	.0	.0	.0	.0	32.2
8-9	.0	15.9	23.2	5.2	.4	.0	.0	.0	44.6
10-11	.0	2.1	3.9	.0	.4	.0	.0	.0	6.4
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.4	.0	.0	.0	.0	.0	.0	.0	.4
IND	.0	.9	.0	.0	.0	.0	.0	.0	.9
TOTAL	2.1	40.8	49.4	6.9	.9	.0	.0	.0	100.0

NUMBER OF OBS 233; MAX WAVE HEIGHT: HGT 4.0, PER 10, DIR 340, TYPE SWL, DA HR 04 00 IND=INDETERMINATE (DIR IN DEGREES)

DEC WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	14.4	13.3	.0	.4	.0	.0	.0	28.4
6-7	.0	11.4	7.0	9.2	21.4	3.5	.9	.0	53.3
8-9	.0	11.8	2.2	.4	2.2	.9	.0	.0	17.3
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.4	.4	.0	.0	.0	.0	.0	.9
TOTAL	.0	38.0	23.1	9.6	24.0	4.4	.9	.0	100.0

NUMBER OF OBS 229; MAX WAVE HEIGHT: HGT 8.5, PER 7, DIR 110, TYPE SEA, DA HR 08 00 IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 17

Selected Gale Observations, North Pacific

November and December 1972

Vessel	Nationality	Date	Position of Ship: Lat. deg.	Position of Ship: Long. deg.	Time GMT	Wind: Dir. 10°	Wind: Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C: Air	Temperature °C: Sea	Sea Waves*: Period sec	Sea Waves*: Height ft	Swell Waves: Dir. 10°	Swell Waves: Period sec	Swell Waves: Height ft
NORTH PACIFIC OCEAN		NOV.															
SS SAN JUAN	AMERICAN	1	41.6 N	175.4 W	00	31	55	5 NM	02	1008.8	11.7	13.4	6	11.5	29	12	29.5
USCGC WINONA	AMERICAN	1	47.3 N	163.2 W	12	06	45	5 NM	63	1012.2	5.0	5.6	8	10	16	8	13
SS AMER ROBIN	AMERICAN	1	43.9 N	149.9 W	18	22	45	10 NM	03	1005.8	20.0	20.0	6	13	28	7	13
SS GALVESTON	AMERICAN	1	50.3 N	129.1 W	00	14	50	.5 NM	65	1005.1	10.0	10.0	6	8	XX	X	16.5
MV ROBERTS BANK	LIBERIAN	1	46.8 N	158.0 W	18	35	45	2 NM	60	989.2	9.0	10.3					
SS SANTA MARIA	AMERICAN	3	52.3 N	131.9 W	06	14	45	5 NM	63	994.6	10.0	11.1	11	23			
MV GEORGIANA	LIBERIAN	3	48.7 N	177.1 E	06	18	M 48	5 NM	58	984.0	6.5	7.0	10	29.5			
SS ARIZONA	AMERICAN	5	45.4 N	173.4 E	00	18	47	5 NM	51	996.5	12.2	10.6	10	21			
MV GEORGIANA	LIBERIAN	5	38.6 N	154.1 E	06	30	M 46	10 NM	02	1014.7	15.0	19.0	6	13			
SS SANTA MARIA	AMERICAN	6	47.5 N	125.0 W	06	14	45	5 NM	50	1005.8	9.4	11.1					
SS THOMPSON LYKES	AMERICAN	6	34.9 N	147.6 E	12	14	45	10 NM	15	1013.9	21.1	23.3	7	8			
SS GAINES MILL	AMERICAN	7	43.8 N	131.7 W	00	28	45	5 NM	02	1001.4	12.8	14.4	XX	13	27	12	19.5
MV GEORGIANA	LIBERIAN	7	41.7 N	172.5 E	18	14	M 60	5 NM	07	1009.0	15.0	15.0	8	29.5	15	>13	39
MV YGUAZU	LIBERIAN	7	46.5 N	164.2 E	18	20	60	10 NM	01	993.0	4.0						
MV HONSHU MARU	JAPANESE	7	49.9 N	175.2 W	06	30	M 50	5 NM	02	1001.0	5.0	7.0	7	13			
SS M M DANT	AMERICAN	7	36.9 N	164.1 E	12	19	M 44	5 NM	02	1011.9	20.6	17.8					
SS OREGON MAIL	AMERICAN	7	46.1 N	164.0 W	12	27	60	5 NM	03	1010.7	7.2	6.0	14	26	27	8	29.5
MV PACKING	LIBERIAN	8	47.2 N	161.1 E	00	25	M 45	.5 NM	49	975.0	8.0	6.0	9	32.5			
MV YGUAZU	LIBERIAN	8	46.2 N	164.0 E	00	25	60	1 NM	05	984.0	6.0						
MV VAN WARRIOR	LIBERIAN	8	51.3 N	174.1 E	18	23	42	5 NM	03	988.0	6.0	6.0					
SS JAPAN MAIL	AMERICAN	8	53.7 N	167.9 W	00	33	45	5 NM	01	1000.7	3.3	4.4	4	5	32	8	14.5
SS INDIAN MAIL	AMERICAN	8	52.5 N	169.2 W	00	32	45	5 NM	03	1011.2	5.0	6.1	6	19.5			
SS OREGON MAIL	AMERICAN	8	46.8 N	158.5 W	00	30	60	2 NM	16	1003.1	6.6	6.0	7	32.5	30	>13	39
SS ARCTIC TOKYO	LIBERIAN	8	48.4 N	159.6 E	06	32	50	5 NM	18	992.0	4.0	6.0	14	19.5			
SS OREGON MAIL	AMERICAN	9	48.2 N	149.0 W	00	29	50	5 NM	25	999.0	7.2	7.2	7	24.5	29	11	29.5
SS JAPAN MAIL	AMERICAN	9	52.6 N	176.6 E	06	26	45	5 NM	83	995.3	3.9	5.0	6	13			
MV VAN WARRIOR	LIBERIAN	9	50.8 N	173.1 E	00	24	41	10 NM	27	995.0	7.0	6.0					
MV MOGAMISAN MARU	JAPANESE	10	45.7 N	170.0 W	18	03	M 43	.5 NM	60	986.0	10.0	7.0	5	10	06	9	23
SS CALIFORNIA	AMERICAN	10	45.7 N	172.0 W	18	04	M 45	2 NM	07	992.5	6.7	8.8	6	13			
MV GEORGIANA	LIBERIAN	10	45.2 N	164.1 W	18	13	M 55	5 NM	54	1000.1	17.5	10.0	6	11.5	15	9	32.5
MV TRANSOCEAN TRANSPORT	PHILIPPINE	10	43.3 N	167.7 W	18	22	M 42	1 NM	61	986.5	13.7	12.3	10	23			
SS PHIL MAIL	AMERICAN	11	38.8 N	160.2 E	12	31	45(P)	2 NM	62	995.0	9.4	17.8	7	8	30	8	14.5
SS CALIFORNIA	AMERICAN	11	46.5 N	161.0 W	18	28	M 60	.5 NM	07	987.1	7.8	9.4	6	13			
MV ATLANTIC PHOENIX	BRITISH	11	39.1 N	159.0 E	00	21	45(P)	1 NM	60	980.0	19.5	17.0	8	19.5			
MV DERWENTFIELD	BRITISH	11	34.1 N	157.8 E	18	29	50(P)	10 NM	02	1010.8	17.8	22.0	7	18			
MV GEORGIANA	LIBERIAN	11	46.2 N	160.1 W	06	22	M 55	5 NM	50	999.5	13.0	10.0	6	13	20	9	32.5
MV VAN WARRIOR	LIBERIAN	11	45.3 N	159.1 E	12	31	47(P)	2 NM	64	980.0	5.0	8.0					
MV VAN ENTERPRISE	LIBERIAN	11	50.0 N	179.5 E	18	13	M 48(P)	5 NM	62	997.0	2.0	5.0					
SS ALASKAN MAIL	AMERICAN	11	41.5 N	167.1 E	18	25	60(P)	.5 NM	90	976.0	8.3	12.2	9	24.5	25	11	41
SS PHIL MAIL	AMERICAN	12	38.4 N	164.2 E	00	29	48(P)	1 NM	52	1007.0	10.0	17.2	8	11.5	29	9	18
MV TRANSOCEAN TRANSPORT	PHILIPPINE	12	45.3 N	160.2 W	00	30	M 46(P)	5 NM	02	1006.5	9.0	12.2	12	26			
MV STAR ATLANTIC	NORWEGIAN	12	40.5 N	154.8 W	00	28	45(P)	2 NM	15	1014.5	14.5	14.0	12	24.5			
MV WIRTA	FINNISH	12	38.6 N	138.4 W	18	25	42	10 NM	25	1006.2	16.7	17.8	6	14.5			
MV VAN ENTERPRISE	LIBERIAN	12	49.6 N	176.4 E	18	27	M 53(P)	5 NM	80	966.0	6.0	5.0					
SS ALASKAN MAIL	AMERICAN	12	41.5 N	168.6 E	00	27	45(P)	5 NM	02	992.2	10.0	13.9	8	29.5	27	>13	41
SS CALIFORNIA	AMERICAN	12	46.5 N	154.7 W	06	30	M 55	5 NM	02	1002.5	8.9	8.9	6	13	30	8	16.5
MV GEORGIANA	LIBERIAN	12	47.1 N	148.4 W	18	34	M 55	5 NM	03	1000.6	7.0	11.0	6	13	33	9	46
MV VAN ENTERPRISE	LIBERIAN	13	49.2 N	175.7 E	00	28	M 48(P)	5 NM	62	981.0	7.0	5.0	10	16.5			
MV WIRTA	FINNISH	13	41.1 N	133.0 W	12	28	42	10 NM	18	992.0	14.5	15.0	6	14.5			
SS CALIFORNIA	AMERICAN	13	46.6 N	146.4 W	00	32	M 45	10 NM	02	1006.5	8.9	10.6	6	14.5			
MV GEORGIANA	LIBERIAN	13	46.6 N	140.7 W	00	33	M 58	10 NM	01	1007.0	8.5	11.0	5	13	33	9	46
MV RITA MAERSK	DANISH	14	35.3 N	161.5 E	18	29	45	10 NM	03	1023.0	15.0	22.0					
MV WIENERTOR	GERMAN	15	39.9 N	172.4 W	06	19	44	5 NM	25	1006.4	15.5	14.4	8	14.5			
SS SAN PEDRO	AMERICAN	15	38.4 N	167.2 E	00	32	42	10 NM	01	1017.3	11.1	16.7	7	10			
MV JANEGA	NORWEGIAN	16	39.6 N	150.0 E	00	31	47	10 NM	02	1003.0	15.0	15.0	7	29.5			
SS AMER LIBERTY	AMERICAN	16	41.0 N	152.9 E	06	31	42	5 NM	03	1007.0	10.0	15.0	14	16.5			
MV WIENERTOR	GERMAN	16	39.6 N	175.0 W	00	27	44	10 NM	18	1014.7	12.4	14.7	10	18			
MV CLARA MAERSK	DANISH	16	36.7 N	131.0 W	18	31	48	5 NM	81	1004.0	16.2	14.0					
SS ARCTIC TOKYO	LIBERIAN	17	51.1 N	172.8 E	06	32	43	10 NM	26	991.0	17.0	6.0	12	13			
MV SYUKO MARU	JAPANESE	17	41.6 N	174.0 W	12	24	M 55	2 NM	64	995.0	11.0	8.0	XX	13			
MV FERNVIEW	NORWEGIAN	17	35.8 N	129.7 W	00	33	42	10 NM	16	1005.5	15.0	17.0	10	19.5			
MV ROBERTS BANK	LIBERIAN	17	46.3 N	149.1 W	06	32	42	10 NM	03	1002.0	9.6	11.0		19.5			
MV BEISHU MARU	JAPANESE	20	49.6 N	166.9 W	12	22	M 41	5 NM	02	973.0	4.0	8.5	8	13			
MV ROBERTS BANK	LIBERIAN	20	39.8 N	166.6 W	06	23	41	5 NM	21	998.6	14.0	13.8		16.5	26	X	23
SS LETITIA LYKES /NEW/	AMERICAN	21	34.1 N	142.5 E	12	25	45	5 NM	02	1005.1	15.7	21.7	7	14.5	25	9	29.5
SS ARCO PRUDHOE BAY	AMERICAN	21	51.3 N	131.9 W	06	14	48	2 NM	07	999.0	11.7	9.4	9	41			
MV TOYOTA MARU # 10	JAPANESE	21	35.9 N	164.6 W	00	23	43	1 NM	60	1004.2	19.9	17.0	7	16.5			
MV HONSHU MARU	JAPANESE	23	46.0 N	162.4 W	18	36	M 54	.25 NM	65	972.5	3.5	8.0	12	21			
MV HONSHU MARU	JAPANESE	24	46.3 N	164.3 W	00	33	M 44	1 NM	87	979.5	4.5	8.5					
SS JOSEPH D POTTS	AMERICAN	24	57.6 N	149.4 W	18	06	50	.5 NM	63	977.0	3.2	7.8	14	39			
MV MARCHEN	DANISH	25	33.3 N	140.5 E	06	27	45	10 NM	01	1010.2	15.0	23.0	6	10	28	8	32.5
SS PHIL BEAR	AMERICAN	25	28.2 N	163.6 W	06	29	45	5 NM	25	1010.8	20.5	25.6	5	10	29	13	13
SS MOBILE	AMERICAN	25	55.6 N	140.8 W	12	22	50	5 NM	64	981.4	5.5	6.7	14	29.5			
SS JOSEPH D POTTS	AMERICAN	25	57.4 N	149.6 W	00	05	55	1 NM	02	965.8	5.5	7.3	14	50.5			
MV BAY BRIDGE		25	51.5 N	143.0 W	00	23	M 42	.5 NM	02	985.0	9.0	9.0	7	16.5	22	12	26
SS SGT TRUMAN KIMBRO	AMERICAN	25	30.1 N	167.3 W	00	33	50	10 NM	02	1010.0	19.9	23.9	13	32.5			
SS MOBILE	AMERICAN	26	55.3 N	141.5 W	00	26	75	5 NM	62	1003.7	5.0	6.7	14	32.5			
SS JOSEPH D POTTS	AMERICAN	26	54.9 N	143.8 W	00	27	47	10 NM	02	1005.8	5.5	7.2	14	49			
SS AVILA	AMERICAN	27	55.2 N	143.5 W	18	10	45	5 NM	02	1008.5	6.1	5.6	XX	5	10	< 6	16.5
SS MALLORY LYKES NEW	AMERICAN	27	34.0 N	138.3 E	12	31	M 45	10 NM	00	1015.2	10.6	21.7					
MV GOLDEN LIGHT	LIBERIAN	27	52.0 N	141.8 W	06	13	M 45	50 YD	65	1018.0	7.0	7.0		10			
SS AVILA	AMERICAN	28	54.7 N	142.4 W	00	13	45	5 NM	02	1006.8	6.7	5.6	XX	11.5	14	7	19.5
MV CITADEL	SWEDISH	28	54.1 N	154.5 W	06	23	60	5 NM	07	1000.0	6.0	9.0	5	19.5			
SS ROSE CITY	AMERICAN	29	39.8 N	161.8 W	00	02	45	5 NM	60	1000.8	12.2	13.4	9	14.5			
MV RAGNHILD	DANISH	29	30.2 N	165.6 W	06	35	45	5 NM	00	1011.5		24.0	10	49			
MV RICHMOND MARU	JAPANESE	29	32.9 N	168.3 W	00	34	M 41	2 NM	16	1013.0	17.0	20.0	7	8	33	12	28
MV TRAVIATA	NORWEGIAN	29	34.6 N	167.2 W	06	34	50	5 NM	18	1015.0	12.5	18.0	6	24.5			

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves† Period sec	Sea Waves† Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH PACIFIC OCEAN		NOV.															
SS TOPA TOPA	AMERICAN	29	37.2 N	163.6 W	06	35	44	2 NM	14	1005.2	10.0	16.7	8	14.5	34	>13	16.5
NORTH PACIFIC		DEC.															
SS CHICAGO	AMERICAN	1	35.1 N	144.0 E	00	25	47	5 NM	02	999.3	13.3	25.6	7	23			
MV CITADEL	SWEDISH	1	54.2 N	175.3 W	00	12	45	1 NM		1016.0	7.5	7.0	10	24.5			
SS PHIL MAIL	AMERICAN	1	53.0 N	177.2 E	00	12	45	2 NM		997.0	4.4	3.9	5	6.5	15	9	11.5
MV JOHAN U	NORWEGIAN	1	33.3 N	147.6 E	18	29	45	5 NM	01	1004.0	15.0	22.0	9	14.5			
SS PRES WILSON	AMERICAN	2	32.2 N	153.3 E	06	27	45	5 NM	01	1004.7	19.4	21.7	9	8	27	10	29.5
SS PIONEER COMMANDER	AMERICAN	2	31.9 N	154.4 W	06	19	45	5 NM	60	1000.0	20.0	21.7	6	8	34	8	10
SS ZIM TOKYO	GERMAN	2	31.9 N	152.4 E	06	28	45	5 NM	83	1004.5	18.3						
SS ARCTIC TOKYO	LIBERIAN	2	39.2 N	148.3 E	06	25	60	2 NM	25	992.0	10.0	1.6	10	16.5			
SS WALTER RICE	AMERICAN	2	16.0 N	95.1 W	00	36	50	5 NM	02	1013.0	27.4	27.5	6	11.5			
MV JOHAN U	NORWEGIAN	2	33.4 N	147.2 E	00	29	45	5 NM	01	1006.0	14.0	22.0	9	14.5			
SS ARCTIC TOKYO	LIBERIAN	3	42.1 N	153.1 E	00	25	50	5 NM	25	1010.0	6.8	1.5	10	16.5			
SS ARCTIC TOKYO	LIBERIAN	4	47.2 N	163.2 E	12	35	45	5 NM	73	1002.0	1.0	5.0	10	16.5			
MV GEORGIANA	LIBERIAN	5	45.7 N	163.9 E	06	26	M 45	10 NM	02	1006.0	3.3	6.0	10	16.5	32	12	26.5
SS WASHINGTON MAIL	AMERICAN	6	47.8 N	134.3 W	06	01	47	5 NM	02	1022.7	5.6	11.1	7	32.5	01	8	32.5
MV LUNA MAERSK	DANISH	7	29.4 N	143.9 W	18	09	45	10 NM	80	1018.5	20.0	21.0					
MV LUNA MAERSK	DANISH	8	27.1 N	139.6 W	12	10	45	5 NM	80	1016.2	19.4	20.0	8	10			
MV JANEGA	NORWEGIAN	9	34.5 N	162.2 W	18	30	45	5 NM	60	1016.0	13.0	16.0	9	16.5			
MV CECILIE MAERSK	DANISH	10	32.1 N	163.2 W	12	31	53	2 NM	80	1007.5	15.4	19.0	9	23			
SS PRES FILLMORE /NEW/	AMERICAN	10	30.0 N	165.9 W	06	34	45	5 NM	02	1017.3	15.6	18.8	2	8	24	6	13
SS AMER CHEIFTAIN	AMERICAN	10	30.9 N	161.2 W	18	32	47	5 NM	02	1001.5	16.1	18.3	XX	19.5	32	13	26
MV JANEGA	NORWEGIAN	10	34.5 N	165.3 W	12	32	60	10 NM	62	1011.0	15.0	16.0	6	19.5			
SS PRES MCKINLEY (NEW)	AMERICAN	11	31.7 N	157.6 W	00	20	41	10 NM	02	989.0	18.9	21.1	10	19.5			
MV JANEGA	NORWEGIAN	11	34.9 N	166.8 W	00	33	60	> 25 NM	03	1015.0	15.0	16.0	4	19.5			
SS STELLA LYKES (NEW)	AMERICAN	12	29.8 N	168.0 E	06	14	45	2 NM	21	1009.1	21.1	18.9	2	8	14	6	13
SS STELLA LYKES (NEW)	AMERICAN	13	30.0 N	173.5 E	00	15	50	5 NM	03	1009.4	20.6	20.0	2	6.5	15	6	14.5
SS SEATRAIN FLORIDA	AMERICAN	13	32.1 N	145.6 E	06	25	45	10 NM	16	1007.5	16.2	22.2	5	6.5	25	7	23
MV HOLLAND MARU	JAPANESE	13	41.1 N	157.5 W	21	04	M 42	1 NM	02	1006.5	12.5	14.5	11	19.5			
MV HOLLAND MARU	JAPANESE	14	39.5 N	158.2 W	03	04	M 42	1 NM	16	1000.5	14.0	14.5	11	19.5			
USCGC WACHUSETT	AMERICAN	15	38.4 N	133.1 W	06	16	M 48	5 NM	61	1004.4	14.5	13.3	6	14.5			
MV ROBERTS BANK	LIBERIAN	15	48.2 N	129.4 W	18	13	55	2 NM	63	993.0	10.0						
SS OREGON MAIL	AMERICAN	16	50.7 N	129.9 W	12	18	48	1 NM	52	988.8	6.0	4.5	6	19.5	18	6	24.5
SS HAWAIIAN CITIZEN	AMERICAN	16	44.5 N	126.4 W	00	18	45	2 NM	61	1002.0	10.0	11.7			18	13	24.5
USCGC CONFIDENCE	AMERICAN	16	58.1 N	138.9 W	18	12	45	5 NM	26	976.6	- 1.0	4.5	4	10			
MV ROBERTS BANK	LIBERIAN	16	48.5 N	128.3 W	00	15	50	2 NM	55	990.5	8.8	9.0	9	18			
SS JAPAN BEAR	AMERICAN	17	36.0 N	175.0 W	18	32	M 48	5 NM	15	994.0	12.2	14.4	4	14.5	32	8	29.5
SS PINE TREE STATE	AMERICAN	17	36.1 N	143.0 W	18	19	50	5 NM	15	996.0	19.4	16.7	7	10			
MV ELISABETH BOLTEN	GERMAN	17	13.2 N	94.3 W	18	34	44	10 NM	01	1014.0	26.7		13	19.5			
SS CHINA BEAR	AMERICAN	17	35.0 N	151.2 W	12	26	41	5 NM	01	987.0	15.6	18.3	8	16.5			
SS HILLYER BROWN	AMERICAN	18	51.5 N	131.5 W	18	12	41	2 NM	41	987.0	7.5	8.9	5	11.5	13	8	18
MV KANANGOORA	SWEDISH	18	29.5 N	175.3 W	06	32	45	2 NM	25	1016.3	14.3	21.5					
MV LIECHTENSTEIN	LIBERIAN	18	43.5 N	135.1 W	12	19	M 45	2 NM	03	987.5	12.0	10.5	8	16.5			
SS PINE TREE STATE	AMERICAN	18	36.6 N	140.3 W	00	23	50	5 NM	03	997.0	19.4	16.7	7	10			
SS GALVESTON	AMERICAN	18	50.2 N	129.3 W	18	13	45	1 NM	65	989.2	7.7	7.7	5	6.5	13	8	23
MV ELISABETH BOLTEN	GERMAN	18	13.5 N	95.3 W	00	01	44	5 NM	01	1013.0	25.0	26.0	11	26			
SS CHINA BEAR	AMERICAN	18	35.8 N	146.0 W	00	26	41	10 NM	02	997.0	19.4	17.7	9	19.5			
MV LIECHTENSTEIN	LIBERIAN	19	41.4 N	137.8 W	12	21	M 42	5 NM	01	1008.5	15.0	12.2	6	11.5	23	8	23
USNS ASTERION	AMERICAN	20	33.7 N	145.7 E	00	05	45	.25 NM	50	1010.8	12.8	20.0	4	5	04	7	14.5
MV HARBOUR BRIDGE		20	44.2 N	178.9 W	12	28	M 47	2 NM	25	973.5	4.0	9.0	10	23			
SS ROSE CITY	AMERICAN	20	33.4 N	159.4 E	18	24	50	5 NM	25	1000.7	20.5	18.9	8	24.5			
SS TOWER BRIDGE		20	43.4 N	179.7 E	18	28	M 40	5 NM	02	999.0	5.1	10.0	6	10	30	12	14.5
MV LIECHTENSTEIN	LIBERIAN	21	36.8 N	147.3 W	12	27	M 60	2 NM	81	1008.0	14.0	16.2	11	19.5			
SS TOWER BRIDGE		21	43.4 N	172.0 W	18	36	M 42	2 NM	63	975.0	3.8	9.0	4	5	02	8	10
SS PRES FILLMORE /NEW/	AMERICAN	21	36.0 N	176.8 E	12	28	45	10 NM	02	1008.1	13.9	15.6	2	10			
SS HAWAIIAN	AMERICAN	22	43.1 N	131.6 W	12	32	45	5 NM	03	1002.0	11.1	13.3	10	10	29	12	16.5
MV JAPAN ACE	JAPANESE	22	40.1 N	157.8 W	06	26	M 45	5 NM	01	998.5	11.0	15.0	12	14.5			
SS TOWER BRIDGE		22	44.2 N	163.7 W	18	29	M 45	5 NM	02	996.0	5.6	9.0	13	14.5			
MV SAVANNAH MARU	JAPANESE	22	40.2 N	160.9 W	00	28	M 45	5 NM	03	993.5	8.0	12.5	14	29.5			
SS AMER AQUARIUS	AMERICAN	22	38.8 N	162.3 W	00	25	45	.5 NM	52	998.2	12.3	14.0	5	14.5			
MV ORIENTAL ESMERALDA	LIBERIAN	23	42.9 N	145.5 W	00	27	45	5 NM	02	999.7	12.0	16.7	7	19.5			
SS PITTSBURGH	AMERICAN	23	49.2 N	137.8 W	00	21	45	5 NM	01	983.0	10.0	7.8	5	13			
SS ROSE CITY	AMERICAN	23	33.4 N	140.5 E	18	12	47	5 NM	81	1006.4	15.6	20.0	14	19.5	13	>13	23
SS TOWER BRIDGE		23	45.2 N	157.6 W	12	27	M 45	2 NM	13	991.0	7.0	9.0	14	21			
SS WALTER RICE	AMERICAN	23	42.7 N	125.8 W	18	18	45	2 NM	51	1010.5	11.7	7.7	3	8	18	9	18
MV LIECHTENSTEIN	LIBERIAN	23	34.4 N	152.9 W	00	28	M 46	5 NM	51	1019.0	17.5	18.0	7	23			
SS PIONEER CRUSADER	AMERICAN	24	42.2 N	137.5 W	18	20	42	5 NM	03	1018.6	14.4	12.8			29	9	11.5
SS TOWER BRIDGE		24	46.6 N	146.7 W	18	23	M 63	1 NM	01	982.8	8.8	9.5	12	19.5			
SS DAISHOWA MARU	JAPANESE	24	47.5 N	141.9 W	00	29	M 50	2 NM	00	999.4	8.3	9.5	12	32.5			
SS DAISHOWA MARU	JAPANESE	25	48.9 N	147.3 W	00	26	M 65	1 NM	23	998.1	6.3	8.0	12	39			
SS INDIAN MAIL	AMERICAN	25	49.0 N	143.6 W	00	25	45	5 NM	81	979.7	8.3	6.7			25	>13	23
MV HONSHU MARU	JAPANESE	25	43.7 N	146.0 W	18	23	M 45	5 NM	02	999.0	10.0	12.0	7	13	26	10	19.5
MV HARBOUR BRIDGE		25	35.0 N	154.1 E	06	26	M 50	2 NM	28	994.0	18.0	20.0	8	19.5			
SS AMER ASTRONAUT	AMERICAN	25	35.5 N	150.3 E	06	31	50	2 NM	15	1000.7	12.2	18.9	5	10	31	>13	32.5
MV JANEGA	NORWEGIAN	26	42.5 N	179.9 E	06	14	56	2 NM	63	994.0	6.0	10.0	8	19.5			
SS IDAHO STANDARD	AMERICAN	26	32.9 N	168.5 E	12	28	45	5 NM	02	1009.0	16.7	21.1	2	10	28	7	21
SS IDAHO STANDARD	AMERICAN	27	34.9 N	169.7 E	00	31	45	5 NM	16	1014.4	15.0	19.4	3	10	31	8	32.5
MV JANEGA	NORWEGIAN	27	44.5 N	173.3 W	12	23	55	2 NM	55	970.0	7.0	8.0	9	36			
SS WASHINGTON TRADER	AMERICAN	27	30.3 N	174.8 E	06	30	45	10 NM	02	1017.3	16.7	20.0	4	8	30	8	24.5
MV CHEVRON MISSISSIPPI	AMERICAN	28	43.4 N	162.1 W	18	27	45	10 NM	02	996.8	7.2	8.9	4	10			
SS YORKMAR	AMERICAN	28	16.0 N	94.5 W	00	32	55	> 25 NM	02	1011.0	25.5	29.0	5	11.5			
SS EXPORT CHAMPION	AMERICAN	29	34.6 N	141.8 E	18	27	45	5 NM	03	997.6	8.9	17.2	9	13			
SS AMER CHALLENGER	AMERICAN	29	24.5 N	122.0 E	06	02	44	5 NM	20	1018.0	13.3	24.4	7	10	02	10	19.5
SS ELIZABETHPORT	AMERICAN	29	33.5 N	150.6 E	12	24	45	10 NM	07	1004.1	19.4	20.6	3	11.5	19	< 6	18
SS PRES MCKINLEY (NEW)	AMERICAN	30	34.8 N	147.6 E	00	26	45	5 NM	02	1002.0	14.4	20.6	4	14.5			
MV VAN WARRIOR	LIBERIAN	30	46.9 N	159.6 E	12	17	50	2 NM	02	966.5	6.0	5.0					
MV ROBERTS BANK	LIBERIAN	30	47.6 N	170.7 E	18	19	60	2 NM	18	989.0	7.2	4.5		29.5			
MV CITADEL	SWEDISH	30	33.0 N	166.8 W	06	30	55	5 NM	07	1001.0	14.0	19.0	5	29.5			
MV WORLD PRIDE	LIBERIAN	30	37.9 N	165.0 W	18	36	45	1 NM	52	1005.0	9.0	13.5	9	36			
MV WILKAWA	BRITISH	30	36.7 N	146.5 E	00	28	44	5 NM	15	999.5	10.0	10.0	10	23			
SS ELIZABETHPORT	AMERICAN	30	34.0 N	147.6 E	00	26	48	2 NM	07	1000.0	16.7	19.4	7	24.5			
MV ROBERTS BANK	LIBERIAN	31	47.2 N	169.6 E	00	24	45	5 NM	02	994.7	6.0	5.2					
MV VAN WARRIOR	LIBERIAN	31	45.7 N	159.1 E	00	27	45	10 NM	22	1000.0	5.0	2.0					
MV CHEVRON MISSISSIPPI	AMERICAN	31	55.9 N	156.0 W	00	32	45	10 NM	01	1009.8	- 5.7	3.9	3	10	32	9	11.5

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves† Period sec	Sea Waves† Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH PACIFIC OCEAN		DEC.															
MV CITADEL	SWEDISH	31	31.2 N	162.5 W	00	27	58	2 NM	80	1007.0	15.0	20.0	6	28			
MV WORLD PRIDE	LIBERIAN	31	35.6 N	166.7 W	06	36	45	1 NM	53	1014.0	9.5	15.0	9	39			
SS ARCTIC TOKYO	LIBERIAN	31	50.3 N	177.2 E	06	18	45	2 NM	18	1003.0	5.0	5.0	14	16.5			
SS GOLDEN BEAR	AMERICAN	31	28.9 N	169.0 W	06	34	M 42	5 NM	02	1017.5	14.5	20.0	4	13	32	8	14.5
OCEAN STATION VESSELS																	
PACIFIC N																	
USCGC RUSH	AMERICAN	6	30.0 N	140.0 W	00	11	M 48	5 NM	07	1011.7	19.0	20.0	7	28			
USCGC RUSH	AMERICAN	7	30.0 N	140.0 W	00	06	M 46	5 NM	80	1015.3	18.8	20.0	6	16.5	09	7	26
USCGC RUSH	AMERICAN	10	30.0 N	140.0 W	00	10	M 42	2 NM	61	1016.2	17.4	19.8	7	14.5			
USCGC RUSH	AMERICAN	14	29.8 N	140.3 W	09	15	M 42	2 NM	80	1009.1	20.2	20.0	7	16.5			

† Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind
(P) Extratropical Pamela

NOTE: These observations are selected from those with winds of 41 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U.S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

(continued from page 169)

14th and 15th. Rains were torrential. On the 12th and 13th, she dumped 17.88 in. on Majuro, as she moved past the atoll on a northwesterly course. Majuro also recorded a maximum wind of 30 kt on the 12th. Violet turned into a tropical storm on the 13th, and reached almost 10°N before reversing her field toward the southwest. She then brushed Kwajalein with 29-kt winds on the 17th. But here again, rain was the real culprit. A new 24-hr amount of 17.15 in. fell, on the 16th and 17th, on the atoll. After this, Violet slowly faded during the next 2 days.

Casualties--The 5,888-ton Pakistanian motor vessel RANGAMATI reported heavy weather damage at Singapore, as did the Cunard CARAVEL after docking at Chiba. The debris from a missing 32-ft cabin cruiser was found in the Gulf of California on San Jose Island on the 5th. The Philippine-registered ST. MARTIN (3,768 tons) sank in heavy seas on the 2d, near 19.5°N, 128.5°E. The HSIN LEE (3,568 tons) of Monrovian registry sank during a heavy storm, on the 12th at 23.9°N, 118.6°E, with 21 crewmembers missing. Heavy seas took the Korean DONGBANG (4,000 tons). She sank 250 mi east-southeast of Shanghai, on the 30th, after springing a leak.

Rough Log, North Atlantic Weather

February and March 1973

ROUGH LOG, FEBRUARY 1973--Overall cyclone activity was slightly below to near normal and concentrated in the western North Atlantic. Two primary tracks, one up the St. Lawrence Valley and the other off the U.S. East Coast, converged over the Labrador Sea. The primary storm track then split again and passed both north and south of Iceland into the Greenland and Norwegian Seas. A primary track that climatologically exists from the Labrador Sea to Baffin Bay was not present this month. Four storm centers generated in, and moved eastward over, the Mediterranean Sea. The eastern and central North Atlantic, generally south of 55°N and east of 40°W, was devoid of cyclone centers except for one weak storm that circled between the Azores and Madeira Island for 4 days, and one that curved south after tracking into the Norwegian Sea. It then moved across the Irish Sea into the Bay of Biscay.

Compared to January, February was a rather quiet month as far as severe storms were concerned. Generally, the LOWS were broken into several centers rather than one large, deep, well-developed center. This resulted in overall maximum winds of lesser intensity in general. There were several exceptions, however.

The climatic mean pressure chart for February has the Icelandic Low near 59°N, 39°W, or about 150 mi southeast of Kap Farvel at 1004.3 mb. A ridge of high pressure extends across the United States and the central North Atlantic, centered on about 28°N, into the Mediterranean Sea. Several small centers of about 1020 mb are indicated. The actual sea level pressure mean chart is quite different this month. The main center of the Icelandic Low is many miles to the northeast, over the Norwegian Sea near 71°N, 13°E at 992 mb. A secondary center is nearer the climatological position, just off Keflavik, Iceland, near 64°N, 25°W, at 998 mb. A sharp trough of low pressure exists from the secondary low-pressure center southwest over Newfoundland to east of Long Island. A large 1033-mb oval High is centered at 40°N, 28°W. The pressure over the United States averaged 5 to 6 mb higher than normal. A small 1011-mb Low was centered over the boot of Italy.

As the above discussion would indicate, rather large anomalies existed over much of the area. By coincidence, the two major anomaly centers were both 17 mb. The negative 17-mb center was in the Barents Sea, north of Nordkapp, Norway. The near circular positive 17-mb center was at 44°N, 28°W. The zero line ran roughly parallel to 20°N in the south and from central France across England to Kap Farvel in the north. A positive 6-mb center existed in Baffin Bay, a positive 8-mb center in northern Quebec Province, and a negative 7 mb over Italy. These anomalies accurately reflect the tracks of the major low centers.

Only one tropical cyclone that reached tropical storm strength has been recorded during February. That storm occurred in 1952. None occurred this

month.

The first significant storm of the month developed over Lake Ontario out of a LOW that came from the midwest. At 1200 on the 3d, the 978-mb pressure center was over the St. Lawrence River just north of Maine. Grindstone Island in the Gulf of St. Lawrence reported 40-kt winds and, early in the day, Ocean Station Vessel "H" had a breezy 35-kt gale prior to frontal passage. A Coast Guard helicopter rescued from dories the five-man crew of the 100-ft fishing vessel SANDRA AND SALLY, which was burning and sinking 40 mi off Gloucester, Mass. Dense fog, gale winds, and 12-ft seas hampered the rescue operations. The LOW continued moving northeastward and by 1200 on the 4th was over Hamilton Inlet. The stronger winds were well to the south along the front between 35°N and 45°N, about 58°W. The ATLANTIC COGNAC was pounded by 50-kt winds and 33-ft waves. At the same time, the HUDSON and JAPAN OAK were buffeted by 40-kt gales.

For the next 48 hr the LOW idled around the Labrador Sea, slowly filling. The strongest winds were 40 kt which were reported north and east of Newfoundland.

On the 1200 chart of the 5th, a new LOW (993 mb) made its appearance about 200 mi south of Reykjavik, Iceland. As the other LOW idled in the Labrador Sea, this one moved eastward and, at 1200 on the 6th, was near 64°N, 1°W. Ocean Station Vessel "I" was battered by 50-kt winds and 36-ft seas. The CUMULUS, at 59.5°N, 4.1°W, reported rain showers and 45-kt westerly gales. The NANOK S, 220 mi to the west, was proceeding at 5 kt against 50-kt winds and 23-ft seas. The LOW proceeded east across the Gulf of Bothnia into the U.S.S.R. on the 8th.

Meanwhile, the original LOW tracked into the Denmark Strait, on the 7th, and then south of Iceland to the Baltic Sea on the 11th.

A 1011-mb wave formed on a cold front over the northern end of Lake Ontario on the 8th. The front extended southwesterly across the eastern United States and Canada out of a LOW in the Davis Strait. As the frontal wave moved up the St. Lawrence Valley, the pressure had dropped to 998 mb at 1200 on the 9th. The center was located north of Anticosti Island, and the front had moved off the U.S. East Coast. A high pressure center was near 48°N, 25°W, drifting slowly eastward. As the pressure gradient increased ahead of the front, several ships reported 40- to 45-kt gales.

It was not until 0000 on the 11th, when the LOW was located near Ocean Station Vessel "A" at 968-mb, that the first 50-kt winds were reported by the NANOK S. as she continued to plod westward at 5 kt. Ocean Station Vessel "B" had a bone-chilling -5°C westerly gale blowing at 45 kt. Ocean Station Vessel "C" experienced 35-kt gales at the frontal passage.

As the LOW passed over Iceland, early on the 12th, the pressure had fallen to 954 mb and its circulation dominated the North Atlantic north of 50°N. Ocean Station Vessel "C" was now being pounded by 60-kt winds and 30-ft seas. Ocean Station Vessel "I" reported 45-kt gales with 36-ft seas and 26-ft swells. Twelve hours later, the 942-mb LOW was near 71°N, 0°. Many ships and coastal stations reported gale-force or greater winds. Ocean Station Vessel "I" and the MEDVEZHEGORSK at 59.5°N, 13.5°W were tossed by 60-kt winds. "I" reported that the seas and swells were both over 30 ft. The NANOK S. fared even worse with 70-kt hurricane-force winds south of Kap Farvel. She was also being battered by 39-ft seas. At 0000 on the 9th, a band of strong winds still existed from Kap Farvel to the Bay of Biscay. The BERDJANSK, in the Bay of Biscay, was pounded by 55-kt storm winds. The NANOK S. was still receiving 45-kt gales and 20-ft seas, but it probably seemed like a spring day compared to the previous 24 hr. Her problems were not over, though; she was again on the receiving end of 50-kt gales and 25-ft seas, 12 hr later at 1200 on the 13th. Gales of 35 to 45 kt were blowing from Greenland to the European coast.

The LOW continued to move northeastward, and several secondary LOWS developed. One of these helped Ocean Station Vessel "I" receive 60-kt near-hurricane-force winds, and 43-ft seas. A coastal station on Iceland and Jan Mayen Island were buffeted by 50-kt winds. On the 14th and 15th, the storm was still picking on Ocean Station Vessels as "I," "J," and "K" were lashed by 50- and 55-kt winds. "J" was rocked by 30-ft seas and 59-ft swells, at 1200 on the 14th, and "K" had 46-ft swells, at 0000 on the 15th. The LOW had split into two centers, one that continued north over Norway and one that moved south through the Irish Sea into the Bay of Biscay where it dissipated. However, the dissipation did not occur before the 51,576-ton Liberian tanker OSWEGO PATRIOT felt its wrath off Cape Priorino. Her rudder was smashed in heavy seas off the coast of Spain and Portugal, and the vessel was in danger of smashing against the rocks of the Cape. The splitting and filling had taken its toll, and the gradient could no longer sustain gale-force winds.

Monster of the Month--We return now to 1200 on the 9th. A 1006-mb LOW formed as a wave on the same front that bred the previous LOW. The TEXAS SUN

Figure 36.--The surf erodes the beach and undermines sections of a motel at Buxton, N. C. Virginian-Pilot photo by Robie Ray.

Figure 37.--One of the oldest hotels along the popular summer resort beach, Nags Head, N.C., was completely destroyed. Virginian-Pilot Photo.

reported 50-kt northerly winds and heavy continuous rain. The BRAZOS in the same area reported 35-kt gales. At 0000 on the 10th, the BRAZOS was still encountering 40-kt gales about 80 mi south of Sabine Pass. The 1002-mb LOW was now just off Tampa Bay. The racing yacht NO WAY rescued eight men off the tug ICE FOG, which was sinking off the southern tip of Florida, at 0430 on the 10th. The yachts BONES and DEVASTATOR also responded to the distress flares. All three were participating in the St. Petersburg to Fort Lauderdale race sponsored by the Southern Ocean Racing Conference. At the time, there were winds of over 50 kt and seas up to 15 ft.

The 990-mb storm crossed Florida and, at 1200 on the 10th, was about 180 mi east of Charleston, S.C. For the next 36 hr, the storm devastated the coastal areas of North Carolina, South Carolina, and Virginia. As the LOW moved over the Gulf Stream, it really wound up. As it moved northeastward up the coast, coastal winds up to 55 kt and sea heights up to 40 ft were reported at the time of the high tide. The waves washed away huge sections of beach (fig. 36) and destroyed or damaged many beach homes and business establishments (fig. 37). Roads were cut by washouts and high water, and power to many areas was interrupted. Heavy rains and snows along the coast stranded thousands of motorists. In South Carolina, where an inch of snow is rare, a record 20 in. fell on the 10th. Thirteen inches of snow fell in North Carolina where 1,200 motorists were stranded in one small town alone. The snow moved northward with the storm, closing many facilities with drifts (fig. 38) as far north as Norfolk, Va. North Carolina's Outer Banks were especially hard hit with barrier dunes and beaches completely washed away. Damages totaling $4.1 million, in insured losses alone, were attributed to the storm by the insurance industry. Uninsured losses will add much more. No loss of life was attributed to the storm.

Offshore was no picnic either, as many reports were received of winds greater than 50 kt and waves up to 36 ft. Among these were the: ESSO HUNTINGTON, 60-kt, 33-ft seas, 36-ft swells; FAIRLAND, 60-kt, 23-ft seas, 25-ft swells; WACOSTA, 55-kt. A ship which could not be identified from the weather chart reported combating 75-kt hurricane-force winds and 30-ft seas. By 1200 on the 11th, the LOW, now down to 986 mb, had moved northeastward and was 310 mi east of Norfolk. The U.S.-registered SEA-TRAIN DELAWARE, at 7,208 tons, returned to

Charleston on the 13th after encountering heavy weather enroute to San Juan. Sixteen containers were lost overboard, and others were crushed. The North Carolina and Virginia coast was still being stung by 45-kt winds. Ocean Station Vessel "H" was riding out 55-kt winds, northwest of the center. The VGBZ, which was east of Nova Scotia, was treated to a heavy snow storm blown by 50-kt winds. Twelve hours later, "H" was still on the receiving end of 50-kt winds and 15-ft swells while the EMERILLON was pounded by 40-kt gales near the center. As the LOW turned northward to pass over Nova Scotia, the circulation broadened but the preseure gradient decreased and gales of 35 to 40 kt were the maximum reported winds.

From the 13th to the 16th, this storm was well behaved. The pressure rose to 999 mb as it passed into the Labrador Sea, but,on the 15th, the pressure again started to fall and the LOW intensified for one last fling. After passing over Kap Farvel, about 0300 on the 15th, the LOW moved up the Denmark Strait and,by 1200 on the 16th, the pressure was again down to 968 mb. The EDITH NIELSEN, near 60.4°N, 33.7°W, was lashed by 60-kt westerly headwinds. The storm paused to rest in the Denmark Strait as an offspring broke off and moved to the north. Early on the 18th, the RANGER BRISEIS was washed by cold rain driven by 50-kt winds, 110 mi south of Iceland. At that time, the LOW again started moving northward into the Greenland Sea graveyard.

A large area of generally low pressure, with several small undeveloped centers existed off the U.S. East Coast on the 21st and 22d. The weather map for 1200 on the 22d indicated one of the LOWS consolidating into a major center. At that time, it was located near 42°N, 53°W. A cold front extended southward from the center,and 12 hr earlier Ocean Station Vessel "E" had reported 40-kt gales. At this time, the wind had increased to 50 kt as the front approached. Another LOW that had tracked from Lake Erie was near 38.0°N, 68.3°W and causing gale winds of 40 kt to the west and south. Cape Hatteras and two ships--the DEAT and the KADY--contended with 40-kt gales. The ASPRELLA and J. R. GREY, south of "E" and ahead of the front, had a breezy 35-kt wind from the stern. South of the LOW, the ATLANTIC FOREST and the LASH ITALIA also had 35-kt gales.

The first LOW moved northward over Cape Race while the second moved northeastward to south of Argentia. Ocean Station Vessel "D" suffered 40-kt gales,and the HYALA, 75 mi to the south, was rolled by a 45-kt crosswind with 26-ft swells off the port side. At 1200 on the 23d, the two LOWS straddled Newfoundland. The INISHOWEN HEAD, which was 700 mi to the east, near 47°N, 36°W, was hit by 75-kt winds during a thunderstorm which was accompanied by hail. The CSDQ in the trough south of the LOWS found a 50-kt wind band near 33.5°N, 61.0°W. At 0600 on the 24th, the two LOWS combined into one and moved eastward, quickly filling and becoming unidentifiable by the 26th.

The last storm of the month had humble origins on the 26th in the Gulf of Mexico, just south of Panama City. It moved across northern Florida and at 0000 on the 28th, was at 35°N, 67°W off Cape Hatteras. The QUEBEC and Experimental Buoy No. 01 (EB-01) both reported 40-kt gales in the northern quadrant. The

Figure 38.--In order to open the many facilities closed at Norfolk Regional Airport by the heavy snow, all available help was utilized. Photo by Virginian-Pilot.

pressure was 1004 mb. In the next 24 hr, the storm raced northeastward and was over the Grand Banks at 996-mb, at 0000 on March 1. At 1200 that day, the LOW passed almost directly over Ocean Station Vessel "C," which was rocked and rolled by 45-kt winds and 16-ft seas as the wind direction changed rapidly. The CHERTAL, 470 mi to the south, was on the receiving end of 45-kt winds. Ocean Station Vessel "D," a few miles to the west, was hit by 50-kt winds at frontal passage.

The LOW continued its mad rush toward Iceland and arrived at 1200 on the 2d. The C. P. TRADER and Ocean Station Vessel "I" both enjoyed 40-kt gales. The LOW idled in the vicinity of Iceland and treated the ANNA JOHANNE, which was 100 mi south of Kap Farvel, to 50-kt winds and snow showers. The storm continued to meander in the area, but lost its punch and identity on the 5th as it split into several centers.

Casualties--The superstructure of the 11,421-ton American freighter YORKMAR was damaged on the 2d when she rammed a railroad bridge across the Chesapeake and Delaware Canal (fig. 39) in heavy rain and fog. One crewman was killed. A train had just cleared the bridge 1 min before the collision. The 11,018-ton Liberian oil tanker NETTUNO dragged her anchor due to heavy weather at Galveston Roads, on the 8th, and collided with the 16,043-ton bulk carrier ZARECHENSK of the Soviet Union. The 26,406-ton LASH ESPANA of U.S. registry was struck and damaged by a quay crane while berthing at Fos-sur-Mer, France, during a gale on the 27th.

ROUGH LOG, MARCH 1973--For the first week and the last several days of the month, high pressure was the dominant feature of the western North Atlantic. High pressure, in general, was predominant over the eastern North Atlantic. Cyclone activity was below normal and the tracks diffuse. A primary track could be said to exist from Nova Scotia to across Iceland, and another possibly from James Bay across Kap Farvel and up the Denmark Strait. Several cyclones formed in and tracked across the Mediterranean area. There was more activity than usual in the central North Atlantic. Cyclone activity was

Figure 39. --The cargo ship YORKMAR, In thick fog, is lodged against the Chesapeake and Delaware Canal Bridge. Damage to the bridge resulted in the closing of the only rail line to the Delmarva Peninsula. United Press International Photo.

weaker than normal throughout the area with fewer storms along the U.S. Atlantic coast. One severe Atlantic coast storm, however, made up for the others that were not present.

The March mean sea-level pressure chart was quite different from the climatological mean chart for the month. The 1000-mb Icelandic Low was centered between Kap Farvel and Iceland, about 350 mi northeast of its usual 1005-mb position. The trough which normally extends to the northeast was deeper and oriented more northerly this month. A 1027-mb high-pressure center was located over the English Channel. The ridge from this High extended over the Azores with several centers along 30°N across the Atlantic. A 1019-mb high-pressure center was over northern Greenland. There were two small 1020-mb centers in Canada near James Bay. The pressure over the eastern half of the United States was near normal, except slightly higher in New England.

The more significant anomalies this month were the positive, rather than the negative. The largest was a positive 12 mb, centered over southern Ireland. A plus 8 mb was centered over Nova Scotia. This is even more anomalous in that a primary storm track passed over Nova Scotia. This can be explained by those LOWS passing through the area not being as deep as usual. A negative 7-mb anomaly occurred in the Denmark Strait. As a matter of interest, a negative 10 mb was centered near the North Pole. A tongue of low pressure extended from that center across the Svalbard Islands to the minus 7-mb center between Kap Mosting and Iceland. As the storm tracks indicate, a large area with a negative 6-mb anomaly was located in the Texas-New Mexico-Oklahoma area.

There were no tropical storms or hurricanes in the North Atlantic.

The first half of the month was relatively quiet across the Atlantic. There were several low-pressure systems, but none really generated into storm producers. Gale-force winds were reported in or around most of these systems, but in only two isolated instances, were winds as high as 50 kt plotted on the charts.

The first storm of the month that appears to be worth describing originated as a small 1002-mb LOW on the south coast of Maine on the 12th. By 1200 on the 13th, it had incorporated the circulation of an older system that tracked out of the mid-United States. The pressure had plummeted to 974 mb, and the center was located slightly northeast of St. John's, Newfoundland. The ATLANTIC FOREST, 600 mi south of the center, had 40-kt gales. The LOW continued to deepen, but remained almost stationary in the vicinity of 50°N, 50°W. It was now the only major cyclonic system in the North Atlantic. The highest winds during this time were reported as 40 kt by SEDCO I.

On the 15th, things started to pick up, as another 1002-mb LOW developed near 37°N, 45°W in the trough associated with the above LOW. This tightened the

Figure 40. --The photographer was in chest-deep water when he took this photograph of a huge wave breaking on the shore of Lake Ontario at the mouth of the Genesee River.

gradient in the area, particularly west of the center. Five ships reported 35-kt gales, and the AMERICAN TRADER and HOEGH ORRIS were buffeted by 40-kt gales northwest and southwest, respectively, of the new center. About 250 mi due west, the BELGRAD experienced 50-kt winds. Twenty-four hours later, at 0000 on the 16th, this center had moved north-northeastward with a central pressure of 984 mb, near 45.5°N, 35.0°W. A stationary HIGH was centered over Ireland, and a strong wind band was created ahead of the front between the two systems. The C. P. TRADER and the WESER EXPRESS both encountered 40-kt gales.

At 0000 on the 17th, the two LOWS combined near 51°N, 38°W. The central pressure increased as the LOW made a cyclonic loop off Newfoundland and disappeared from the charts on the 19th.

This storm's major feature involved the Great Lakes. It developed as a wave on a front in Mississippi early on the 16th. At 0000 on the 17th, the LOW was in central Kentucky at a 996-mb pressure. A broad area of cyclonic circulation had started to develop. At 1200 on the 17th, the 980-mb LOW was centered near Cleveland and the winds were causing havoc to shore areas throughout the Lakes. Added to this were blizzard snow conditions, with many inland areas receiving over 10 in. with drifts of 4 to 6 ft. Winds from the northeast through the northwest with speeds of 30 to 50 kt were recorded from Lake Ontario to Lake Michigan on the 17th and 18th. Estimates of 60-kt were given on Lake Huron. The Coast Guard received reports of waves of 8 to 12 ft; the highest at Erie, Pa., of 10 to 12 ft. Water in Saginaw Bay and River was 7 ft above normal and extended as far as 5 mi inland. The record high water levels of the Great Lakes added to the destruction and flooding from the winds and waves. Because of the time of the year when ships have not started to operate, no ship reports were received. The first shipping through the locks and canals started on March 28.

Millions of dollars worth of damage was incurred to property (figs. 40 and 41), and thousands of people were displaced from flooded and damaged homes. It was estimated that this storm was more destructive than the November 14-15, 1972, storm. See the March 1973 issue of the Mariners Weather Log for a description of this storm.

Back at sea on the 17th, the ESSO BOSTON was lashed by 40-kt gales off Charleston, and, on the 18th, Ocean Station Vessel "H" was pounded by 40-kt winds and 16-ft seas. At that time--0000 on the 18th--the 972-mb LOW was over Kingston, Ontario. Later on the 18th, the following ships reported 40-kt gales from Nova Scotia to Charleston, S.C.: FORT DE FRANCE, Ocean Station Vessel "H," USNS MAU-

Figure 41. --These summer cottages on the shore of Lake Michigan are only an example of the damage caused by erosion in the March 17 storm. Wide World Photo.

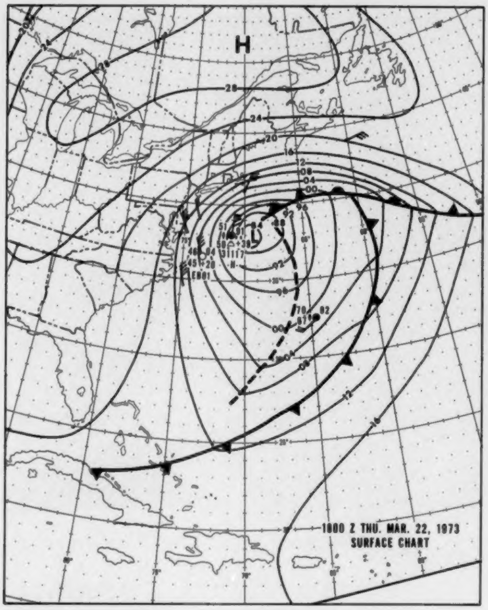


Figure 42. --An analysis of the surface weather chart for 1800 on March 22 displaying the Monster of the Month.

Figure 43. --The vicious storm as seen by the NOAA 2 satellite at about 1530 on March 22.

MEE and VGBZ. On the 19th, a second LOW developed south of Newfoundland to the east of the parent LOW. The strongest winds remained just off the coast where the ATLANTICA MARSEILLE, DONGA, GYPSUM QUEEN, and RU YUNG were buffeted by 40-to 45-kt gales, driving seas, and swells up to 30 ft.

The easternmost LOW took a northeasterly track and rapidly moved over Iceland, on the 21st, to disappear in the Barents Sea. The original LOW moved over Newfoundland, on the 20th, prior to curving southeastward for 24 hr. Starting on the 22d, the storm gained new energy. Ocean Station Vessel "D" combated 50-kt winds as the center passed north of its station. By the 23d, the pressure had dropped to 972 mb and the circulation had expanded considerably. At 1200 that day, the center was at 56°N, 22°W and the BREITLING, at 51.5°N, 27.5°W, about 300 mi to the southwest, wrestled with 50-kt northwesterlies. As the LOW moved over the pressure ridge protecting the European land mass, Ocean Station Vessel "J" was torn by 40-kt gales and confused waves. She was tossed by wind waves from the northwest of 33 ft, with swells of 23 ft from the north and 13 ft from the west. The KRPAN, further south, about 700 mi from the center, had higher winds of 50 kt but calmer sea and swell waves. As the storm moved across the top to Scotland it rapidly deteriorated and, by the 26th, was only a trough line on the weather charts.

Monster of the Month--This superstorm, which apparently caused the sinking of two ships, had its beginning in that incubator of storms--the Texas, Oklahoma, New Mexico area. A low-pressure area (1002 mb) consolidated, on the 19th, in Oklahoma and started an easterly track. A warm front extended to the east and a cold front to the south. The center moved steadily eastward at about 20 kt with little change in intensity, until late on the 21st, when it crossed the coast near Cape Hatteras. Here is where things happened. At 1200 on the 22d, the LOW was down to 984 mb, near 37°N, 70°W, and ships knew it was in the area. At 0000 that day, Ocean Station Vessel "H" was battered by a 50-kt easterly wind. The CHARLESTON, about 50 mi northeast of the center, was buffeted by 45-kt gales, 13-ft seas, and 13-ft swells. That was only an appetizer for later. The NIKOLAI DANILOV was engulfed in moderate snow blown by 60-kt winds about 70 mi off Cape May. At 1800, Ocean Station Vessel "H," about 65 mi west of the center, radioed a report of 70-kt hurricane-force winds from the north (figs. 42 and 43). At that time the seas were running at 28 ft at her position. It has been reported that the GRESHAM (Ocean Station Vessel "H") suffered winds in excess of 65 kt for a period of 8 hr. Gusts were up to 88 kt. Seas averaged 30 ft, but many 50-ft seas were observed. The lowest pressure observed was 985 mb. The ship sustained structural damage, including the loss of several lifeboats. Additionally, some crewmembers were injured, with one requiring evacuation by helicopter. The Environmental Buoy (EB-01), off Norfolk, reported only 40-kt gales.

The NORSE VARIANT, a 13,194-ton Norwegian freighter, sank 130 mi southeast of Cape May (approximately 37.4°N, 72.8°W) at about 1800 on the 22d. She radioed that she was sinking and the 30 crewmen were taking to lifeboats. There was a report that a hatch had broken open. Coast Guard and Navy ships, and Air Force search and rescue aircraft all combed

Figure 44.--Seaman Stein Gabrielsen is assisted from the Coast Guard helicopter on board the USS INDEPENDENCE.

the area for survivors. On the 25th, an Air Force search aircraft spotted seaman Stein Gabrielsen, 23 (fig. 44), in a liferaft 250 mi southeast of Cape May, N.J., more than 100 mi from where the ship went down. He had survived 3 days on the raft in raging seas with 40-ft waves and 70-kt winds. Two paramedics parachuted into the sea to Gabrielsen's aid. He was put aboard the MOBIL LUBE. A Coast Guard helicopter picked him up from the tanker and transferred him to the aircraft carrier INDEPENDENCE. He was reported in good health. Six ships and four aircraft continued the search, but no other survivors were found.

The Norwegian motorvessel ANITA, also carrying a cargo of coal, has been missing since March 21. The vessel was reportedly in the same area as the NORSE VARIANT when she sank in the violent storm. The ANITA carried a crew of 29. At last reports, no survivors or other evidence of her fate had been found, but a lifering bearing her name was recovered.

As the storm churned up the coast, many ships felt its wrath. Fifty-knot winds or greater were reported in the semicircle from 500 mi to the northeast to the coast, to 440 mi to the southwest, early on the 23d. Among them were the USCGC CAMPBELL, PORTLAND, VASSIUI SOURIKOU, VGBZ, and the WEWW. The VODB was blasted by 60-kt winds and 30-ft seas about 160 mi east of Wallops Island, Va. Nearby a ship reported being ravaged by heavy rain, 65-kt hurricane-force winds, and 40-ft seas. Twelve hours later, at 1200 on the 23d, the storm was fixed by aircraft reconnaissance at 38.0°N, 64.5°W with a pressure of 971 mb. At that time the strongest wind reported was 60 kt by the USCGC ACTIVE and USCGC CAMPBELL in the north and northwest quadrants of the storm. Gale- and storm-force winds extended up to 600 mi in all quadrants. The highest sea and swell was 33 ft in the northeast and southeast quadrants. The Outer Banks of North Carolina took another beating for 3 days. At least five motel units and two beach cottages were destroyed. A February storm also wrought havoc in this area. Considerable flooding and beach erosion again occurred.

The LOW was tracking almost due east, and at 0000 on the 24th, was near 38°N, 61°W, at a pressure of 972 mb. It was still a vicious storm as the ATLANTICA NEW YORK could attest as she was rocked and rolled by 70-kt hurricane-force winds and 30-ft swells from the north-northeast on her 10-kt westerly course. Her position was 40.3°N, 64.0°W or about 210 mi northwest of the center. Later on the 24th, the storm hatched a secondary LOW to the northeast of the center and the central pressure started to rise. This weakened the circulation, and 45-kt winds were the maximum plotted. The storm now turned northeastward and, as it encountered colder water, it rapidly dissipated and was buried at sea on the 26th north of Ocean Station Vessel "D."

On the 25th, a high-pressure center moved off the

U.S. East Coast. A LOW was located in the midwest. As the systems moved eastward, the ESSO HUNTINGTON, near 34°N, 75°W, was buffeted by 45-kt gales. Twelve hours later, at 1200 on the 26th, the LOW split into two centers and the frontal system moved over the coastline. In the tight pressure gradient ahead of the front, Ocean Station Vessel "H" experienced 45-kt winds and the USNS SAUGATUCK reported 40-kt gales. As the HIGH moved eastward, the LOW that formed near Norfolk moved to the northeast up the slope of the Bermuda High and into the Norwegian Sea, on the 30th; it had little effect on shipping.

At 0000 on the 28th, a 994-mb LOW formed in the trough near 34°N, 68°W. Another HIGH was pressing in from Canada resulting in a dumbbell-shaped LOW. At 0000 on the 28th, Ocean Station Vessel "H" was agonized by 50-kt winds, now from the opposite direction--the northeast. The H 1070, USCGC ACTIVE, and the VGBZ, all reported 45-kt gales. The high-pressure area off Bermuda was now breaking down into the main circulation of the Azores High, and the LOW moved eastward. For the next 24 hr, the ATLANTICA MARSEILLE was treated to 45- and 50-kt headwinds and seas to 23 ft. The Canadian High moved across the top of the LOW on the 28th and 29th. On the 31st, the LOW split into two centers again. The 7,891-ton Greek-registered KIMOLOS was driven aground at the entrance to St. Pierre and Miquelon off Newfoundland. The LOWS were now fenced in on three sides by high-pressure areas. One moved northeastward and was absorbed on April 1. The other meandered in the vicinity of 37°N, 52°W until April 2.

Casualties--Besides the two ships that sank in the Monster of the Month, the following casualties occured. Caught in a gale in western Turkey, the 11,511-ton German tanker, T.P.A.O.I., grounded at Aleaja Bay and the 7,375-ton Turkish freighter MUSTAFA grounded in Tekudag, Sea of Marmara. The HENRY FORD II was stuck in ice 4 mi from the Detroit River Light. The 12,039-ton MANCHESTER CHALLENGE for Montreal ran aground in ice on March 8 near Buoy 68L in the St. Lawrence River. The 8,101-ton Italian motorship GALILEO FERRAIS ran aground in strong winds when entering the Port of Sardinia. The British ASIAFREIGHTER, under tow, was making little progress due to heavy weather. The Greek tanker (8,886 tons) ELEFTHERIA was aground when a sudden storm caused the vessel to bump against a jetty at Yarimca in the Gulf of Izmit, Turkey, on the 19th. Pushed aground when she lost power and steering in Lake Maracaibo, was the 17,539-ton British tanker GOLDEN TOBIN. Ice damage to the bow plating was sustained by the Greek motorvessel SPARTAN BAY in the Gulf of St. Lawrence.

Rough Log, North Pacific Weather

February and March 1973

ROUGH LOG, FEBRUARY 1973--The cyclone storm tracks were above normal in number over the entire area, except into the North American west coast. Activity in the general area of 30° to 50°N and 125° to 150°W (off the U.S. west coast) was above normal, but only two centers crossed the coastline. The primary storm track from southern Japan took a more easterly course than normal, into the central North Pacific, before turning north to the Gulf of Alaska. Usually this track follows just south of the Aleutian Islands. A secondary track into the Bering Sea was further west than climatology indicates. Several centers made cyclonic loops in that area.

The mean sea-level pressure pattern for this month was a near carbon copy of the climatological pattern. The major difference in configuration was an elongated closed high-pressure center roughly located between 20° to 30°N, 130°W to 170°E. Higher pressure than usual dominated the western United States. A small High that normally exists between California and Hawaii was displaced westward and replaced by a low-pressure trough. The Aleutian Low at 52°N, 168°E, was near its climatological position but 9-mb lower than normal.

There were five significant anomaly centers, three negative and two positive. A negative 9-mb center was located near the Aleutian Low. Farther east, a negative 6-mb was slightly south of Unalaska and a negative 9-mb was off the California coast, near 38°N, 136°W. A positive 7-mb center was near the middle of the Pacific at 29°N, 170°W. The other positive, at 5-mb, was north of Salt Lake, Utah.

There were no tropical cyclones in the North Pacific this month.

The first significant storm of the month originated as a wave on a front south of Shikuku, Japan, on the 5th. At that time and until the 7th, a dual LOW system straddled Japan. The first gale-force winds were reported, at 0000 on the 7th, when the 978-mb center was near 45°N, 158°E. The JAPAN AZALEA and YAMANASHI MARU reported 40-kt gales midway between the LOW and Japan. Ahead of the front, at 34°N, 163°E, the MANJUSAN MARU had a 45-kt southerly crosswind. Twelve hours later, the now consolidating storm was at 48°N, 162°E. Two hundred miles east of Tokyo, the JDZE was headed west into a northwest maelstrom. By the 8th, the circulation around the LOW dominated the western half of the ocean. At 1200, the LOW was centered at 51.5°N, 168.0°E, with a pressure of 956 mb. During this 24 hr, the KANEOKA MARU, JAPAN AZALEA, JUZAN MARU, SITKA MARU, SPINDRIFT ISLE, and a weather ship reported being buffeted by 40- to 50-kt winds. The KANEOKA MARU, 720 mi south of the center, encountered 39-ft swells. The SPINDRIFT ISLE had the highest winds of 50 kt. The center moved into the Bering Sea on the 9th, and the HAKUYO MARU, 200 mi southeast of the center, was pounded by 50-kt winds and 20-ft seas. The cold water rapidly defeated the storm late on the 10th.

This little jewel was mined in Manchuria, but polished in the mid-Pacific. The 1008-mb center passed

through the Tsugaru Strait about 0000 on the 14th. Twelve hours later, the HIFI MARU, 200 mi west of the center, and two other ships were battered by 40-kt gales. At 1200 on the 15th, the ASIA MARU, near 37°N, 173°E, 175 mi southeast of the LOW was buffeted by 50-kt winds. The storm continued tracking eastward and early on the 16th was at 43°N, 180°. The SHUKO MARU, 450 mi to the south, was rocked by 50-kt winds and 33-ft seas and swells. The following ships reported 35- to 45-kt gales south and west of the center: CHOZAN MARU, HIFI MARU, HOHKOKUSAN MARU, OVERSEAS PROSPER, STELLA LYKES, SUNIMA, TOYOTA MARU NO. 1, and TOYOTA MARU NO. 12. At 1200 on the 16th, the XOFAN MAIL, at 41°N, 171°W, was blasted by 60-kt winds off her stern. Winds of 35 to 45 kt continued to blow in all quadrants as the LOW moved northeastward toward Alaska. The system now started to break down as a new LOW was discovered to the south. The division of energy and the vitality of the new LOW was too much for the dull and worn jewel as she was lost in the Alaska Peninsula on the 19th.

This 1007-mb LOW appeared south of Honshu Island, at 1200 on the 19th. It was in a hurry to leave, though, and 24 hr later was at 42°N, 152°E, and the pressure was 977 mb. The JEHE, north of the center, plowed through heavy snow blown by 40-kt winds. The LOW was now tightly wound with gale-force winds in all directions. The 1200 analysis on the 21st indicated a central pressure of 948 mb at 52°N, 165°E. The NANSHO MARU and the REIHO MARU, east and south of the center, encountered 40- and 45-kt winds, respectively. The Kuril Islands were blasted as Ostrov Urup was battered by a 50-kt storm and Ostrov Ketoy barely survived 90-kt. On the 22d, the LOW had moved into the Bering Sea and the central pressure started to rise. The WASHINGTON MAIL, near Rat Island in the Aleutians, was lashed by 55-kt winds and waves of 33 ft. Early on the 23d, the island of Ostrov Beringa was ravaged by 70-kt hurricane-force winds. Farther to the south of the LOW's center, 35- to 45-kt winds were the order of the day. The WASHINGTON MAIL was bucking 50-kt winds with 33-ft seas and high swells, 620 mi south-southwest of the storm. At this time, the pressure had risen to 990 mb and a new LOW had developed on the front south of the Aleutians. Within hours, this upstart had encompassed the circulation and was now the primary feature on the charts in that area.

This LOW formed in a trough left behind by a previous LOW, which had moved up the Kuril Islands. At 1200 on the 24th, the 984-mb center was located near 40°N, 155°E. A large circulation developed very rapidly and, by 0000 on the 25th, many ships were aware of its presence. The TRENTON, near 36°N, 151°E, battled a 60-kt crosswind from the northwest. The AMERICA MARU at 35°N, 159°E and the ORIENTAL LIGHT near 39°N, 158°E both experienced 55-kt storm winds. Gale winds extended as far as 1,200 mi south and southwest of the center, which was at 46°N, 165°E. The LOW was on a northerly track and still deepening. It reached its lowest pressure of 956 mb, on the 26th, off the Kamchatka Peninsula. The extent of gale winds had decreased but not their speed. The BANARIO, CANADA MAIL, and PEARL VENTURE were buffeted by 50-kt winds from the southwest to the east of the center. The LOW had now curved west and started a cyclonic loop. At the same time, the pressure also started rising. The AMSTELHOF was riding out 50-kt winds and 50-ft swells about 300 mi west of the Near Islands. In the same area, the JUNEAU MARU had struggled against a 55-kt storm, 12 hr earlier. On the 1200 chart of the 27th, the LOW had split, straddling the Kamchatka Peninsula. Also, a small wave had developed on the front. These combined factors quickly weakened the circulation and pressure gradient, and the LOW that formed in the Sea of Okhotsk became the dominant system.

A general low-pressure area caused by the development and dissipation of a series of LOWS had dominated the eastern ocean, between Hawaii and California for many days. The last of this series started a northerly track into the Gulf of Alaska on the 25th. At 1200 on the 26th, a frontal wave and LOW formed near 35°N, 141°W (300 mi north of Ocean Station Vessel "N"). Minimal gale-force winds had been reported in the area for the past 48 hr. As the LOW intensified and moved eastward the winds picked up rapidly. At 2300 on the 26th, the SEATRAIN LOUISIANA radioed a special report of 70-kt hurricane-force winds, near 32°N, 136°W, about 190 mi south of the 987-mb center which was near 35.5°N, 136.0°W. The wind was accompanied by 26-ft seas and 33-ft swells. An hour later, at 0000 on the 27th, the CHICAGO, in the same general area (32.5°N, 138.1°W), was also ravaged by 70-kt winds. The seas had increased to 60 ft by this time. No report of swell heights was included. Ocean Station Vessel "N" rode out 55-kt winds and 30-ft seas. The LOW rapidly moved northeastward and crossed the California coast near San Francisco, about 0200 on the 28th. After that initial surge of strength, the storm assumed a more normal behavior with minimum gales. The CLARA MAERSK, headed southward near 30.3°N, 126.0°W, was the only ship to report winds as high as 35-kt for the next 36 hr. At 0000 on the 28th, the report from the TONAMI MARU near 44.5°N, 133.0°W indicated 60-kt winds. This odd report was north of this LOW and south of the LOW in the Gulf of Alaska. As the storm moved onto the coast, rain was reported from San Diego to Seattle.

Casualties--Thankfully, casualties were light this month. The 124-ton Japanese fishing boat, No. 50 TAIHEI MARU, with a crew of 15, was last heard from, on the 6th, off Siberia in rough seas. The 9,365-ton WASHINGTON MAIL arrived at Yokohama with heavy weather damage to the forecastle.

ROUGH LOG, MARCH 1973--Cyclone activity in the North Pacific, overall, was above normal. Nearly all LOWS traversed the primary track from Japan, northeastward to the Bering Sea and the Gulf of Alaska. The more severe storms, except for one, seemed to favor the more westerly path into the Bering Sea. The LOWS that normally move out of Siberia across Sakhalin Island were further south and tracked across Korea and Japan where they joined the primary track originating south of Japan. LOWS from the Gulf of Alaska into the North American west coast took a more southerly direction and crossed the Oregon and California coasts rather than the British Columbia coast. The two secondary tracks that climatologically originate off the U.S. coast and then

cross the coast, were absent.

The monthly mean sea-level pressure chart closely resembled the climatic chart in configuration, but the mean values were more extreme. The Aleutian Low had a mean pressure of 992 mb--13 mb deeper than the 1005-mb climatological value. The center was located at 50°N, 170°E, which was 180 mi southeast of its normal position. The Pacific High, at 1031-mb pressure, was 9-mb higher than the 1022-mb climatological High. The centers very nearly coincided. The Siberian High was 6-mb greater than average with a cutoff High center over the Cherskiy Mountains. The mean pressure along the U.S. West Coast and over Japan was near normal.

There were two major negative anomalies. The first, a minus 13-mb, coincided with the Aleutian Low center. The second, a minus 10-mb, was centered over Cordova, Alaska, in conjunction with the overall lower pressure for the month. Two major positive anomalies also resulted from the month's weather patterns. A plus 10-mb was associated with the Pacific High. The other, a positive 6-mb, resulted from the cutoff HIGH over Siberia. The pressure over Siberia, in general, was slightly higher than climatology indicates.

No tropical storms occurred in the North Pacific this month.

The first storm of the month had its beginning south of Kyushu near 38°N, 129°E, on the 4th. Within 24 hr, the pressure had plummeted to 990 mb and the center was 400 mi east of Tokyo. By 1200 on the 5th, the 971-mb center was at 36.5°N, 157.5°E. One hundred miles ahead of the LOW, the WASHINGTON MAIL, which had previously been cruising through fog, now was buffeted by 50-kt winds with seas and swells of 33 ft. The LOW had raced north of the MALLORY LYKES treating her to 45-kt gales near 28°N, 151°E. The LOW's circulation was spreading rapidly as the SILVER ARROW, south of Tokyo Bay, reported 45-kt winds. The GRAND INTEGRITY and the OCEANANAJIN collided in Yokohama Outer Harbor due to strong wind gusts.

The 6th was really the big day for the now powerful 958-mb storm, located at 45°N, 169°E. The highest wind reported was 60 kt out of the north about 120 mi west of the center, by the SEINE MARU. She also was bounced by 26-ft seas and 33-ft swells. Fifty-knot winds were found in all quadrants of the storm by the HOYO MARU, JAPAN POPLAR, and the MARCONAFLO MERCHANT. To the northeast and northwest of the center, the DAIKI MARU and the WAKAMIYASAN MARU were moving toward each other in a blizzard. The heavy snow was driven by 35-kt gales.

On the 7th, the LOW was the dominant weather influence over the western North Pacific. Forty-knot winds were the strongest reported, but the tightest circulation south and east of the center would indicate stronger winds. The JAPAN POPLAR, PACIFIC LOGGER, and TONAMI MARU had the dubious distinction of having these winds. On the 8th, the 952-mb LOW was at 50°N, 172°E. For over 24 hr, Ostrov Beringa had northeasterly winds of at least 50 kt. Gale-force wind reports now covered the Pacific from 30°N to 65°N and from 150°E to 165°W. Of course, there were reports of lesser winds interspersed throughout this area. The strongest wind band was off the Siberian coast, stretching southwestward from the Bering Strait to the Kuril Islands. The influx of cold air from the Bering Sea and the colder water, as the LOW moved northward, started to take its toll, and the now dual-centered storm was dying. Late on the 9th, another LOW, to the south, was moving eastward and absorbed much of the circulation. Only the secondary LOW remained to drift into Alaska.

This LOW was first discovered south of Tokyo Bay, on the 8th, as a 1011-mb depression. It did not take long for it to develop. By 0000 on the 9th, it had raced to 34°N, 160°E. A ship, which could not be identified, near 33°N, 158°E, about 100 mi from the center, was lashed by 60-kt winds. The MAYAYSIA FORTUNE, 300 mi to the south-southwest, was heading northwestward with a 50-kt crosswind.

By 1200 on the 10th, this LOW was near 46.5°N, 179.5°E and had a pressure of 952 mb. The SEA SPIRIT and the SHINTO MARU, south and northeast of the center, respectively, rode out 50-kt gales and seas to 20 ft. The YAMAAKI MARU, at 39.6°N, 175.8°E, really had a rough time for a while. The 50-kt winds were blowing moderate rain and stirring up 21-ft seas from the southwest while 33-ft swells were rolling by from the northwest. Early on the 11th, the LOW crossed the Aleutian Islands into the Bering Sea. The JFAE and the YGUAZU, both about 400 mi south of the center, were battered by 50-kt storm winds. The Pribilof Islands were lashed by northeasterly 50-kt winds. The LOW tracked up the Aleutians and, on the 12th, crossed into Alaska and was defeated by the snow-covered mountains. The STAR ACADIA was the last ship to feel the wrath of the storm.

The area south of Japan was very prolific in spawning storms this month. A general area of depression existed on the 12th. By the 13th, one of the LOWS had developed and moved eastward. At 1200 on the 13th, it was near 39.5°N, 150.0°E, at a 986-mb pressure. It was on the 14th that things broke loose. The MANDARIN VENTURE, east of the front, encountered 70-kt hurricane-force winds and 30-ft swells from the east-southeast. The TOTEN MARU, 200 mi to the south, suffered only 50-kt winds, as did the TRANSOCEAN TRANSPORT, near 44°N, 156°E, with 30-ft seas. The LOTUS reported only 25-kt winds as the center passed almost directly over her position at 0000 on the 14th. Later that day, the JDGQ was lashed by 55-kt winds, just off Ostrov Iturup and the VENEZUELA MARU, at 39.6°N, 156.7°E, was hammered by a 60-kt storm wind driving 16-ft seas and 26-ft swells. The 962-mb storm reached its lowest pressure near 44.5°N, 156.5°E. On the 15th, the WORLD INFLUENCE, south of Attu Island, would have liked to influence the 50-kt freezing wind she was battling. The LOW continued its north-northeastward movement, now filling as it approached the Bering Sea. Once into the Bering Sea, an almost explosive filling occurred, and by the 18th, the LOW no longer existed.

This LOW originated in the vicinity of Japan as did the others, but this time further south. As previously, the original deepening was very quick. By 1200 on the 17th, the pressure was 968 mb, a drop of 41 mb in 36 hr. At that time, the LOW was at 39.5°N, 157.7°E, and the SULEYMAN STALSKIY, 90 mi due south, could barely proceed against the 80-kt hurri-

Figure 45.--This NOAA 2 photograph was produced from the visible spectrum of the scanning radiometer data. The LOW is centered near 43°N, 157°E, at 2224 on March 17. Another storm is over the Gulf of Alaska. The Aleutian Islands and Bering Sea coastlines are clearly visible.

cane-force winds off her port bow. She reported 10-ft seas atop 40-ft swells. Figure 45 is a NOAA 2 IR picture of the storm at 2224 on the 17th. At 1200 on the 18th, the 968-mb LOW was 47.5°N, 161.3°E. Three ships reported winds of 50 to 55 kt in an arc about 220 mi to the south. They were the SANTA MONICA MARU, the SEIHO MARU, and an unidentified ship that was also battered by 36-ft seas. The LOW moved up nearly the same track as its predecessors as if in a rut. As usual, the pressure started to rise as the storm neared the Bering Sea. On the 19th, the DAISHOWA MARU, 500 mi southeast of the center, found a 50-kt wind band.

The progress of the LOW was now very slow as it approached the Near Islands, and a frontal wave raced across the ocean south of it. Early on the 21st, this new LOW completely absorbed the original one.

This LOW first had an opportunity to affect shipping, on the 20th, as it moved into the Sea of Japan. This was not its start though, as it had spent many previous days tracking across the southern U.S.S.R. The storm moved rapidly across Japan and, on the 21st, was near 40.5°N, 150.0°E. The pressure was 998 mb. Thirty-six hours later, at 0000 on the 23d, the pressure was 952 mb and the center was at 45.5°N, 165.0°E. The MEISHUN MARU was only about 60 mi from the center when she reported 50-kt southerly winds. The AIKO MARU was about 300 mi south of the center, and was boosted along by 50-kt westerlies. Twelve hours later, she was getting an additional 5 kt of wind. The DAIAN MARU was rolling west as fast as the 60-kt rain storm, 20-ft seas, and 20-ft swells out of the north, would allow.

On the 24th, the LOW had curved to an easterly path. The JHHE found the same strong wind band south of the center that the other ships encountered. The swell had increased to 33 ft. Slightly farther west, the TOKUSEI MARU was battling 50-kt gales which decreased to 35 kt 12 hr later. Early on the 25th, the LOW moved across Adak Island into the Bering Sea and, within a few hours, was a mere trough after having survived the rigors of Siberia, earlier.

This was another LOW that had a continental origin, appearing in the Sea of Japan, on the 28th, at 1003 mb. It stayed on a more easterly track and made it into the Gulf of Alaska. The LOW had galloped to 38°N, 157°E, by 0000 on the 29th. Within the hour, it had passed very close to the FEDERAL MACKENZIE, which was pounded by 70-kt shifting winds. One good thing was that the speed that the LOW was moving, it would not effect any one place or ship for too long at a time. The FEDERAL MACKENZIE, which was moving in the same direction as the LOW, reported only 30-kt gales, 12 hr later. The LOW reached a pressure of about 990 mb and continued moving northeastward at about 30 kt.

The LOW was of little danger to shipping for the rest of its lifespan. On the 31st, the ELLEN BAKKE was buffeted by 45-kt gales and the HONOLULU MARU had 40-kt gales. The ELLEN BAKKE appeared to have tracked north-northeastward with the LOW. At 0000 on the 1st, she was experiencing a 40-kt southwesterly gale. On the 2d, the LOW was well into the Gulf of Alaska with a pressure of 1003 mb. On the 3d, the LOW disintegrated south of Valdez, Alaska.

Casualties--The 20,877-ton U.S.-registered tanker, EAGLE LEADER, arrived at Honolulu on the 5th, with alleged weather damage. The Cypriot motorship MARINER (7,916 tons) was abandoned by the crew when she encountered rough weather at 35.0°N, 152.8°E. Twenty-nine passengers were injured when the Japanese ferry boat UWAJIMA (900 tons) collided with the 17,715-ton Liberian LILAC, in the fogbound Bungo Channel. Both ships suffered minor damage.

Marine Weather Diary

NORTH ATLANTIC, MAY

WEATHER over the North Atlantic continues to moderate during May. The Azores High builds slightly to a central pressure of 1022 mb near 31°N, 40°W, while the Icelandic Low centered several hundred miles southeast of Greenland's southern tip fills to about 1012 mb.

WINDS over the greater part of the ocean between 40° and 55°N are generally westerly, except northeasterly over the Baltic Sea, but with less persistence than during April. The average wind speed north of 40°N is force 4. Winds are quite variable between 55° and 60°N and are generally northerly north of 60°N. Between 25° and 40°N, winds are somewhat lighter, generally of force 3. West of 40°W, within the above latitudinal belt, south and southwest winds tend to prevail; while east of this longitude, winds from the northerly quarter of the compass are by far the most frequent of all. Over Mediterranean waters, west-northwesterly winds of force 2 to 3 are the most common. The Gulf of Mexico plays host to easterly force 3 winds. The "northeast trades," force 3 to 4, dominate the wind regime between 5° and 25°N, except along the African coast where they extend northward to about 30°N. South of 5°N to the Equator, the force 2 to 3 winds almost always have an easterly component.

EXTRATROPICAL CYCLONES continue to develop frequently from off the Carolina coast northeastward to Newfoundland, but are less severe than during April. The direction of movement from Newfoundland is generally either north toward the Davis Strait or northeast toward the Norwegian Sea. Two primary tracks affect the Great Lakes. One runs east-southeastward from Lake Winnipeg to south of James Bay. Another follows a line from eastern Iowa across southern Lake Michigan and southern Lake Huron to lower Quebec. After meeting, the two tracks proceed as one to the Gulf of St. Lawrence.

GALES are rare below 40°N, and their frequency and duration in higher latitudes are less than in the preceding months. The area of maximum likelihood of gales, 10 to 20 percent, generally is located from the southern tip of Greenland southward to about 52°N between 40° and 56°W.

TROPICAL CYCLONES are infrequent during May. During the 31-yr period, 1942-72, five tropical storms occurred and two of these attained hurricane force.

SEA HEIGHTS of 12 ft or more are encountered from 5 to 10 percent of the time along the northern shipping lanes from several hundred miles east of the Chesapeake Bay to the northern Norwegian coast, excluding the North Sea and the Bay of Biscay but including the Gulf of Lions southeastward to Sardinia. The frequency increases to more than 10 percent in the midocean area and to more than 20 percent south of Kap Farvel.

VISIBILITY limited to less than 2 mi is encountered 10 to 20 percent of the time over the western North Atlantic from about 40°N, 65°W, northeastward to a point near 53°N, 30°W, and then westward to the Labrador Sea. The line, north of which frequencies are greater than 10 percent but less than 20 percent, then extends northeastward over Kap Farvel to north of Iceland and through the Norwegian Sea to the Barents Sea. Visibility less than 2 mi also occurs between 10 and 20 percent of the time over a great part of the northeastern North Sea. Frequencies increase to over 20 percent of the time over the Grand Banks and off the southwest coast of Greenland.

NORTH PACIFIC, MAY

WEATHER continues to improve slowly over the North Pacific in May. The subtropical High has an average central pressure of about 1022 mb and is located near 34°N, 152°W. The Aleutian Low becomes a broad weakening trough extending from the Asia mainland eastward to the western Gulf of Alaska. The lowest pressure, about 1008 mb, is centered over the west-central Bering Sea.

WINDS north of the 25th parallel tend to come from the westerly quarter of the compass, but variable winds are present over a number of locations on either side of the dateline. Winds over the Gulf of Alaska are easterly at force 3 to 4. Along the U.S. coast, northwesterly components are pronounced. Between the Equator and 25°N, (30°N, east of 180°), the "northeast trades" are very steady, except over the southern half of the South China Sea where southerly winds of the southwest monsoon have established themselves. These monsoon winds are usually force 2 to 3, though lighter winds are not unusual. Over most of the rest of the North Pacific, wind speeds average force 3 or 4. Northerly and westerly winds prevail out from the Gulf of Tehuantepec with easterly and northwesterly winds close behind. Speeds are force 2 or 3 48 percent of the time.

EXTRATROPICAL CYCLONES continue to develop over the Ryukyus and then move east-northeastward toward the Gulf of Alaska. A second primary storm track crosses the Siberian coast and Sakhalin, continues eastward across the northern Kuril Islands, and then curves toward the southern Bering Sea.

TROPICAL CYCLONES. Tropical storms occur, on the average, about once each year over the western ocean. There have been years with none, and some years with as many as four. Roughly 85 percent of these tropical storms become typhoons. The areas of most frequent development are south of 20° N. from the Carolines westward across the Philippines and the South China Sea. About once every 2 yr, a tropical storm or hurricane develops over the ocean area off Mexico during May.

SEA HEIGHTS of 12 ft or more are encountered from 10 to less than 20 percent of the time in two areas south of the Aleutians and north of 45°N. One area is bounded roughly by the ellipse formed by the points 52°N, 46°N, 170°E, 165°E; another larger area proceeds southeastward from Atka Island to 45°N, 160°W. N., 160° W.

VISIBILITY less than 2 mi occurs more than 10 percent of the time over the western North Pacific Ocean north of 35°N and over the eastern North Pacific Ocean north of 42°N and west of 140°W, excluding the Gulf of Alaska and the waters southeast of the central Aleutians. Over the northern Kurils this low visibility occurs more than 30 percent of the time.

NORTH ATLANTIC, JUNE

WEATHER over the North Atlantic is usually very pleasant in June. The number of active extratropical LOWS continues to decline, and storms are usually confined to higher latitudes. The building Azores High averages near 1024 mb for the month and is centered over midocean near 33°N, 38°W. The Icelandic Low, oriented east-west, is quite diffuse with the lowest average pressure about 1010 mb, just off the coast of Labrador.

WINDS are controlled largely by the Azores High. Between 25° and 55°N, southwesterly winds predominate, except over the eastern ocean from the Bay of Biscay southeastward, where northerly winds prevail. South of 25° to about 5°N, the "northeast trades" are generally steady. North of 55°N, winds are mostly variable. On the Mediterranean, east to southeast winds are common over the western half, while northwest winds blow steadily over the eastern portion. Northwesterly winds prevail over the eastern Gulf of Mexico while southeasterly winds are predominant over the southern North Atlantic between the Equator and 5°N. Wind speeds over most of the North Atlantic during June are force 3 to 4. Lighter force 2 to 3 winds are most common over the Mediterranean Sea, Davis Strait, Gulf of Mexico, Bay of Biscay and waters southwestward, and near the Equator.

EXTRATROPICAL CYCLONES are fewer in June than in May and not as intense. Cyclogenesis throughout the summer occurs principally in the area from the Carolinas, west of 65°W, to Hamilton Inlet, Labrador, west of 50°W; north of Scotland; northwest of Iceland; over the waters southwest of the British Isles; and over the Gulfs of Finland, Riga, and Bothnia. The major storm tracks during June extend from the Newfoundland area northeastward to the waters south of Iceland and then northeastward across the Scandinavian Peninsula. Another primary track extends from Iowa across central Lake Michigan to southern Lake Huron and down the St. Lawrence River where it joins a track that develops off Cape Cod.

GALES over the North Atlantic are infrequent during June. Only in the waters near southern Greenland and over northern portions of the Norwegian Sea does the probability of encountering gales exceed 10 percent.

TROPICAL CYCLONES. Tropical storms average about one every 2 yr. The preferred area of tropical cyclone formation is over the western Caribbean and the Gulf of Mexico. The 31-yr period, 1942-72, had 17 tropical storms, and eight reached hurricane strength.

SEA HEIGHTS of 12 ft or more occur between 5 and 10 percent of the time northward of a line drawn from east of the Grand Banks to west of Ireland, and west of a line drawn from west of Ireland to the southern boundaries of the Norwegian Sea and then south of Iceland to the Denmark Strait. Other smaller areas encompass the waters between Norway and the Shetland Islands, the waters off the central Norwegian coast, and the Gulf of Lions. Frequencies reach 10 percent or more only over an elliptical area immediately south of Kap Farvel.

VISIBILITY. The frequency of fog approaches its maximum over the northern ocean. The Grand Banks is the foggiest region--visibility below 2 mi is reported on more than 30 percent of all observations. The percentage of this low visibility decreases to between 20 and 30 percent of the observations over the Davis Strait and the northern Labrador Sea and over the waters east of Kap Brewster, Greenland. The latter area is usually ice-covered at this time of year. The fog is generally observed in warm, moist air brought by southerly winds into this area of cold ocean temperatures.

NORTH PACIFIC, JUNE

WEATHER. The summer regime is well established over the North Pacific in June. Vigorous extratropical storms are less frequent than in May. The subtropical High is centered near 36°N, 149°W, and has an average central pressure of about 1024 mb. The Aleutian Low, located north of the western Aleutian Islands, fills rapidly during June; by the end of the month, it has disappeared.

WINDS north of 25°N are somewhat variable, but southerly to southwesterly winds are most abundant with a few exceptions. Westerly to northwesterly winds prevail over the waters surrounding the western Aleutians and the Komandorskiye Islands. Northwesterly winds also prevail east of 140°W (north of the 40th parallel), and winds from the northeast quarter of the compass predominate east of 160°W (north of the 30th parallel). Wind speeds average force 3 to 4 north of 25°N. South of 25° (30° east of 145°W) to the Equator, steady "northeast trades" dominate, with force 4 the most common wind speed reported. On the South China Sea, however, the southwest monsoon is well established and southerly winds prevail. These winds average about force 3. Winds out from the Gulf of Tehuantepec usually blow from the northern semicircle, and 53 percent of all winds are force 2 or 3.

EXTRATROPICAL CYCLONES. The most favorable area for cyclogenesis continues to be east of Honshu. The primary storm tracks lead from here east-northeastward to the Gulf of Alaska. Another track

approaches the Gulf of Alaska on a northeasterly course from midocean.

GALES are rare in June. Only over a small area near 46°N, 145°W, does the chance of encountering gales exceed 5 percent.

TROPICAL CYCLONES. The probability of tropical storm development continues to rise sharply in June, approaching the late summer and early fall maximum. On the average, three of these storms deve[illegible] per year--one or two during this month in Asiatic waters and one or two over the ocean area between 10° and 20°N and the Mexican west coast and 120°W. About two out of three western North Pacific tropical storms go on to become typhoons. One out of three eastern North Pacific storms reach hurricane intensity.

SEA HEIGHTS of 12 ft or more have a frequency greater than 10 percent only in two small areas. One is centered south of the Alaska Peninsula near 48°N, and the other south of the western Aleutians near 46°N. In general, sea conditions are considerably improved over those of May.

VISIBILITY. The frequency of low visibility increases over most of the North Pacific. The waters east of the northern Kuril Islands are particularly foggy, with the visibility dropping below 2 mi in over 40 percent of the observations. From the outer boundaries of this area northward to Kamchatka, southward to the the central Kurils, westward to the eastern Sea of Okhotsk, and eastward to 162°E, this percentage drops to 30 to 40 percent of all observations. The area of this low visibility, which encompasses 20 to 30 percent of all observations, extends from the southern Sea of Okhotsk through the central Kurils and then eastward through the North Pacific along the 40th parallel to 165°W. The line bordering the boundary of the area then bends westward to midocean near 47°N, 175°E, before curving northeastward through the central Aleutians to St. Lawrence Island in the Bering Sea.

GLOSSARY OF METEOROLOGICAL TERMS USED IN THE SMOOTH LOGS, ROUGH LOGS, AND THE MARINE WEATHER DIARY

From time to time as space permits a glossary defining some of the more technical meteorological terms used in the monthly weather summaries will appear in the Mariners Weather Log. This glossary will contain words or groups of words which your editor feels are the most difficult to grasp.

The set of terms appears in alphabetical order. Should omissions occur, we will be happy to define any other troublesome expressions which are brought to our attention.

Alberta LOW--A LOW centered on the eastern slope of the Canadian Rockies in the province of Alberta, Canada.

Formerly, it was thought that such LOWS actually originated (more or less independently) over this location. It is now recognized that depressions moving inland from the Pacific are the actual parent systems. Alberta LOWS appear as these systems enhance, or are enhanced by, the dynamic trough, which is a typical, almost semipermanent, feature of this region.

anomaly--the deviation from normal of pressure, temperature, precipitation, etc., in a given region over a specified period.

anticyclone (High or HIGH)--a closed atmospheric circulation containing higher pressure than its surroundings, having a sense of rotation opposite to that of the earth's rotation: that is, clockwise in the Northern Hemisphere, counterclockwise in the Southern Hemisphere, undefined at the Equator.

backing--a change in wind direction in a counterclockwise sense (e.g., south to southeast to east) in either hemisphere of the earth; the opposite of veering.

center of action--any one of the semipermanent Highs and Lows that appear on mean charts of sea level pressure. The main centers of action (differentiated in the text from all-capitalized synoptic-type LOWS and HIGHS by capitalization of only initial letters) in the Northern Hemisphere are the Icelandic Low, the Aleutian Low, the Azores High, the Pacific High, the Siberian High (in winter), and the Asiatic Low (in summer). Fluctuations in the nature of these centers and other less intense systems are intimately associated with relatively widespread and long-term weather changes.

cold front--any nonoccluded front, or portion thereof, that moves so that colder air replaces warmer air; i.e., the leading edge of a relatively cold air mass.

Colorado LOW--A LOW which makes its first appearance as a definite center in the vicinity of Colorado on the eastern slopes of the Rocky Mountains. It is, in most aspects, analogous to the Alberta LOW.

convection--atmospheric motions that are predominately upward vertical, resulting in vertical transport and mixing of atmospheric properties, sometimes producing convective clouds; e.g., cumulus.

cut-off LOW--a cold LOW in the upper atmosphere which has become displaced out of the basic westerly current, and lies to the south of this current.

cyclogenesis--any development or strengthening of cyclonic circulation in the atmosphere; the opposite of cyclolysis. It is applied to the development of cyclonic circulation where previously it did not exist (commonly, the initial appearance of a LOW or trough), as well as to the intensification of existing cyclonic flow. While cyclogenesis usually occurs together with deepening (a decrease in atmospheric pressure), the two terms should not be used synonymously.

cyclolysis--any weakening of cyclonic circulation in the atmosphere; the opposite of cyclogenesis. Cyclolysis, which refers to the circulation, is to be distinguished from filling, an increase in atmospheric pressure, although the two processes commonly occur simultaneously.

cyclone (Low or LOW)--a closed atmospheric circulation containing lower pressure than its surroundings, having a sense of rotation the same as that of the earth's rotation : that is, as viewed from above, counterclockwise in the Northern Hemisphere, clockwise in the Southern Hemisphere, undefined at the Equator.

cyclone family--a series of wave cyclones occurring in the interval between two successive major outbreaks of polar air. The series travels along the polar front (the front separating air masses of tropical and polar origin), usually eastward and poleward.

Typically, the polar front drifts eastward and equatorward, so that each cyclone of the family has its origin and trajectory at a lower latitude than the previous cyclone.

dynamic trough (lee trough)--A pressure trough that forms on the lee side of a mountain range across which the wind is blowing almost at right angles; often seen on U.S. weather maps east of the Rocky Mountains, and sometimes east of the Appalachians, where it is less pronounced.

Its formation may be explained by the warming owing to the compression of the sinking air on the lee side of the mountain range, or by the generation of cyclonic circulation (cyclogenesis) caused by the horizontal convergence associated with the vertical stretching of air columns descending the lee slope.

extratropical--typical of occurrences poleward of the belt of tropical easterlies. When applied to cyclones, this term refers to the migratory frontal cyclones of middle and high latitudes.

filling--an increase in the central pressure of a pressure system. The term is commonly applied to a LOW (Low) rather than a HIGH (High).

meridional--longitudinal, northerly or southerly; opposed to zonal.

mistral--a north wind which blows down the Rhone Valley south of Valence, France, and then over the Gulf of Lions. It is strong, squally, cold, and dry. A general mistral usually begins with the development of a depression over the Tyrrhenian Sea or Gulf of Genoa with an anticyclone advancing from the Azores to central France. It often exceeds 50 kt; it reaches 70 kt in the lower Rhone Valley and 40 kt at Marseilles, decreasing both east and west and out to sea. A general mistral usually lasts for several days, sometimes with short lulls. It is most violent in winter and spring, and may do considerable damage.

monsoon--a name for seasonal winds. It was first applied to the winds over the Arabian Sea, which blow for 6 mo from the northeast and for 6 mo from the southwest, but it has been extended to similar winds in other parts of the world. The monsoons are strongest on the southern and eastern sides of Asia, the largest land mass, but monsoons also occur on the coasts of tropical regions wherever the planetary circulation is not strong enough to inhibit them. The primary cause of a monsoon is the much greater annual variation of temperature over large land areas compared with neighboring ocean surfaces, causing an excess of pressure over the continents in winter and a deficit in summer, but other factors such as the relief features of the land have a considerable effect.

northeast trades (trade winds, trades)--the wind system, occupying most of the Tropics of the Northern Hemisphere, which blows from the Azores High or Pacific High toward the equatorial trough; a major component of the general circulation of the atmosphere.

The trade winds are best developed on the eastern and equatorial sides of the great subtropical highs, especially over the Atlantic. They begin as north-northeast winds at about latitude 30° in January and latitude 35° in July, gradually veering to northeast and east-northeast as they approach the Equator. Their southern limit is a few degrees north of the Equator. Over the Pacific, the trade winds are properly developed only in the eastern half of that ocean.

The northeast trades are characterized by great constancy of direction and, to a lesser degree, speed; the trades are the most consistent wind system on earth.

norther--in the southern United States, especially in Texas (Texas norther), in the Gulf of Mexico, in the Gulf of Panama away from the coast, and in Central America (norte), the norther is a strong cold wind from between northeast and northwest. It occurs between November and April, freshening during the afternoon and decreasing at night. It is a cold air outbreak associated with the southward movement of a cold anticyclone. It is usually preceded by a warm and cloudy or rainy spell with southerly winds. The norther comes as a rushing blast and brings a sudden drop of temperature of as much as 25° F. in 1 hr or 50° F. in 3 hr, in winter.

occluded front (occlusion)--a composite of two fronts, formed as a cold front overtakes a warm front or quasi-stationary front. This is a common process in the late stages of wave cyclone development.

prevailing wind--the wind direction most frequently observed during a given period.

primary cyclone--any cyclone, especially one associated with a front, within whose circulation one or more secondary cyclones have developed. See secondary cyclone.

quasi-stationary front (LOW)--a front or LOW which is stationary or nearly so. Conventionally, one which is moving at a speed less than about 5 kt is generally considered to be quasi-stationary.

ridge (wedge)--an elongated area of relatively high atmospheric pressure, almost always associated with an area of maximum anticyclonic curvature of wind flow, similar to a high but not containing its closed circulation.

secondary cyclone--a cyclone which forms near, or in association with, a primary cyclone.

U. S. DEPARTMENT OF COMMERCE
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Environmental Data Service
WASHINGTON, D.C.

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
210

U.S. MAIL

supertyphoon--a typhoon which attains sustained wind speeds of 130 kt or more.

tehuantepecer--a violent squally wind from the north or north-northeast in the Gulf of Tehuantepec (south of southern Mexico) in winter. It originates in the Gulf of Mexico as a norther which crosses the isthmus and blows through the gap between the Mexican and Guatamalan mountains. It may be felt up to 100 mi out at sea.

triple point--a junction point of three distinct air masses, considered to be an ideal point of origin for a cyclone; i.e., near the junction of an occluded front, cold front, and warm front.

tropical--typical of occurrences within the belt of tropical easterlies. When applied to cyclones, refers to a cyclone that originates over the tropical oceans. At maturity, the tropical cyclone is one of the most intense and feared storms of the world; winds exceeding 175 kt have been measured, and its rains are torrential.

By international agreement, tropical cyclones have been classified according to their intensity as follows : a) tropical disturbance, having a slight surface circulation and one closed isobar (a line of equal or constant pressure) or none at all; b) tropical depression, with winds equal to or less than 33 kt, and with one or more closed isobars; c) tropical storm, with winds of 34-63 kt; d) hurricane or typhoon, with winds of 64 kt or higher.

trough--an elongated area of relatively low atmospheric pressure similar to a low but not containing its closed circulation. As portrayed on a Northern Hemisphere synoptic chart, a trough in midlatitudes normally dips southward. In low or very high latitudes, troughs (inverted) usually push northward.

veering--a change in wind direction in a clockwise sense (e.g., south to southwest to west) in either hemisphere of the earth; the opposite of backing.

wall cloud--the doughnut-shaped ring of clouds surrounding the eye of a fully-developed tropical cyclone. The strongest winds and the largest pressure gradient are usually found here.

warm front--any nonoccluded front, or portion thereof, which moves in such a way that warmer air replaces colder air.

warm sector--that area, within the circulation of a wave cyclone, where the warm air is found. It lies between the cold front and warm front of the storm; and, in the typical case, the warm sector continually diminishes in size and ultimately disappears (at the surface) as the result of occlusion.

wave cyclone--a cyclone which forms on and moves along a front. The circulation about the cyclone center tends to produce a wavelike deformation of the front. The early stage in the development of a wave cyclone or a poorly developed wave cyclone is called a wave disturbance.

zonal--latitudinal; easterly or westerly; opposed to meridional.

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.